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ABSTRACT

This second of four sections in a curriculum guide for training energy extension agents contains general introductory materials, an overview of the total curriculum, and eight modules: Alternative Energy Sources (Solar and Wood), Basic Graphics and Blueprint Reading, Building Materials, Electricity, Introduction to Cooling Systems, Introduction to Heating Systems, Insulation and Ventilation, and Lighting Efficiency. The curriculum is designed for adults with at least eight grade reading and math skills but without previous technical training. Following a brief description of the project which developed the curriculum (Project EFFECT--Energy for the Future: Education, Conservation, Training), these supplementary materials are provided: energy extension agent competencies, core curriculum outline, and class calendar for the eight-month program. The modules for technical training comprise the bulk of the curriculum and assure a realistic, practical focus by providing for field trips, observations, practical experiences, and lectures by instructional faculty and others from the professional and business community. Contents of each module include objectives; teaching/learning activities, resources, and evaluation (quizzes and examination) keyed to the objectives; and syllabi containing descriptions of content on a class-by-class basis. Also available in ERIC are a volume containing sample worksheets, handouts, and examinations for each module as well as full references to all outside sources needed; other sections of the guide; and a final report of the project--see Note. (YLB)

CE 025 101

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PROJECT EFFECT

Energy For The Future: Education, Conservation, Training

CURRICULUM GUIDE

for the training of

ENERGY EXTENSION AGENTS

A WORKING PAPER

Section II
Technical Training
October 1979

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PROJECT EFFECT

Curriculum Guide for Training

ENERGY EXTENSION AGENTS

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PROJECT EFFECT

Curriculum Guide For Training

ENERGY EXTENSION AGENTS

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PROJECT EFFECT

CURRICULUM GUIDE

INTRODUCTION

Objectives and Activities

The most critical problem facing mankind in the near future is making the best use of our precious energy resources. The problem is first to change the attitudes of people about energy use. Particularly in the United States, the idea of unlimited, inexpensive energy for all must give way to conservative, thoughtful use of limited energy resources. Once people become aware of the need for immediate action to prevent drastic hardship in the future, they require reliable and unbiased information upon which to act. As resources dwindle and technology advances, the public must be kept informed of new developments so that they can continue to use energy effectively.

In its effort to address the need for technically trained manpower and informed citizens, Project EFFECT developed objectives in the three basic areas of Curriculum Development, Training, and Community Education, as follows:

1. To create a comprehensive training program for adults without previous technical training, applicable to community energy conservation needs, and usable in other communities in a variety of regions.

2. To define the new occupational role of Energy Extension Agent and to provide training for this agent, who would become a new community resource.

3. To heighten community awareness of energy conservation.

To meet these objectives, the project engages in the following major activities:

1. Production of a package of training materials on energy utilization and management, tested both with trainees and the community participants;

2. Selection and training of a team of Energy Extension Agents;

3. Placing the Energy Extension Agents in local agencies and organizations and businesses as energy utilization technicians;

4. Application of energy conservation techniques in the community through residential audits and community, neighborhood and agency workshops;

5. Establishment of a community resource file of people and agencies;

6. Promotion of community education about energy utilization through local, regional and national media emphasis;

7. Delivery of materials and workshops outside of the immediate project region.

Two additional major components in the area of technical assistance and curriculum evaluation and dissemination are:

1. Short term workshops, seminars, and institutes are conducted for technical personnel, utilities, public and governmental agencies, and include continuing education for Project graduates;

2. Regional and national conferences are conducted to evaluate the training program and to share curriculum development activities with others in the field.

An advisory committee made up of professionals from local business, industrial, educational and governmental institutions give valuable guidance in shaping the curriculum and in recruiting teaching staff from outside the university. In particular, much of the practical instruction in heating and cooling, insulation, and building codes is conducted with the help of community professionals in these fields.

The Project is funded by the U.S. Office of Education, Community Service and Continuing Education Branch, under a Title I grant.

Progress and Accomplishments

Since project start-up in October 1977, an eight-month curriculum has been developed and field-tested with two groups of trainees. The July 1978 class was entirely supported by three local CETA agencies (South Bend, St. Joseph County, and Elkhart County) and sixteen students were graduated. The 1979 class included some students funded by CETA (South Bend and St. Joseph County) but most class members were self-supporting. Ten were graduated in July 1979. Graduates are employed with governmental agencies, community action agencies, construction firms, architectural contracting firms and insulation contractors. Other placement opportunities are being developed in city-government, state energy offices, local industry and educational systems, and utilities.

In addition, Project EFFECT staff has conducted pilot two-day workshops for the South Bend Community School Corporation's physical plant superintendents and staff and for Indiana and Michigan Electric Company field representatives.

Additional activities include an energy curriculum evaluation workshop held in 1978. A small task force representing Federal offices, curriculum development and training programs and energy conservation experts was invited to conduct an intensive critique of the EFFECT curriculum. Second year revisions in the training program were based on their suggestions as well as on the lessons learned from the first training session.

Finally Project Staff is developing a series of workshops for the Indiana State Energy Group in five sites throughout Indiana. The workshops will enable local education agencies and hospitals to conduct energy audits of their facilities in order to qualify for Federal aid to institute energy-conserving changes.

ORGANIZATION OF CURRICULUM GUIDE

The curriculum materials are organized into four main sections and color coded as follows:

Section I - General Background (gold)
Section II - Technical Training (green)
Section III - Energy Audit Preparation (buff)
Section IV - Community Education (blue)

Each section contains general introductory materials and an overview of the total curriculum. Within each module are included objectives, resources and references, a class syllabus keying each session to the objectives, and evaluation materials such as final exams or descriptions of other evaluation strategies.

SUPPLEMENTARY MATERIALS

COMPETENCIES OF THE ENERGY EXTENSION AGENT

The Project EFFECT curriculum is designed to develop the technical and communication skills necessary to conduct an energy use survey and to explain the results of the survey to the general public. Upon completion of this eight month program, the Project EFFECT graduate can:

Conduct an energy use survey of a residential or light commercial structure, which includes:

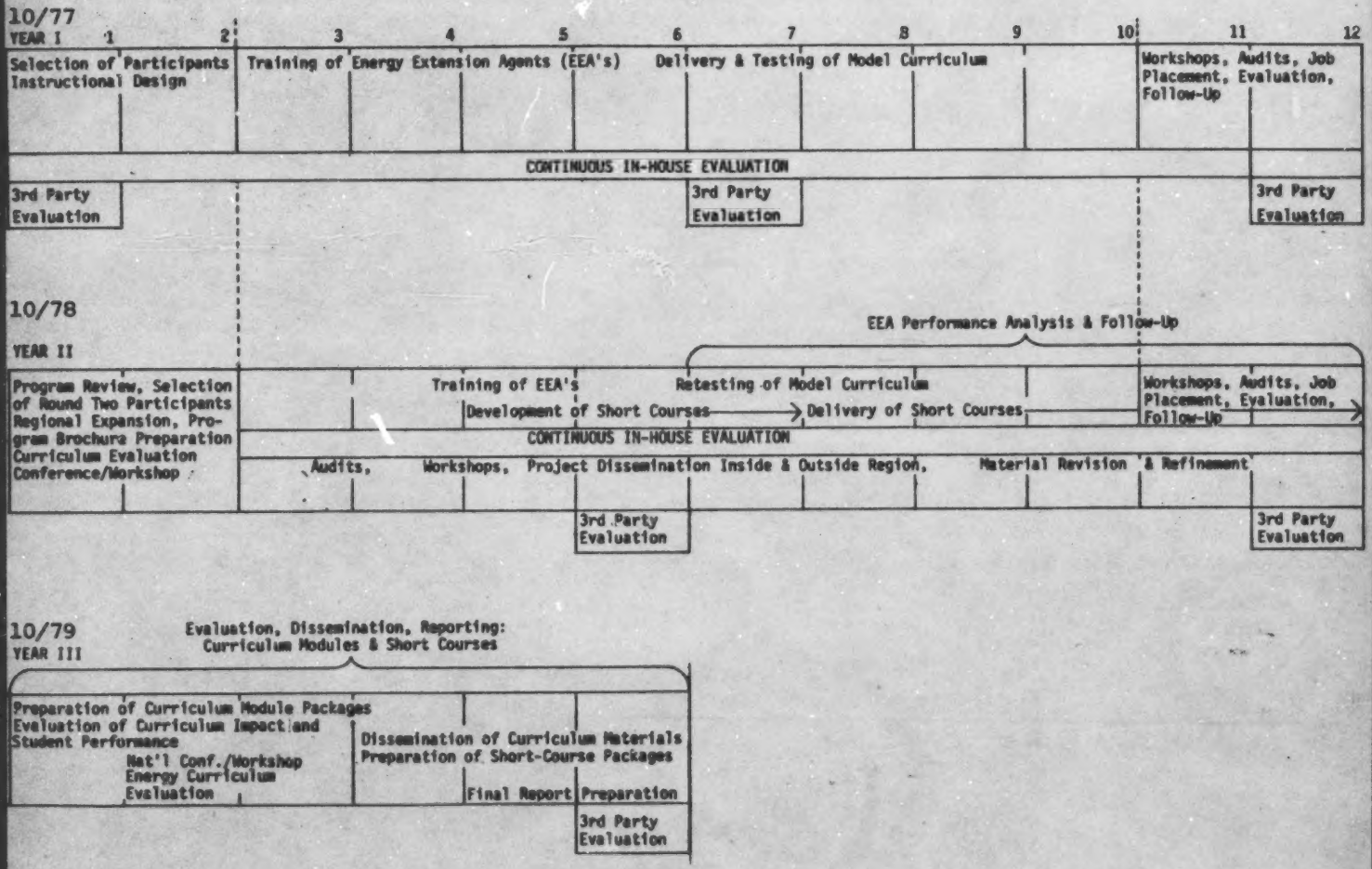
- ....a simple sketch of the structure, including plan and elevation views, showing all relevant details;
- ....an exact accounting of heat losses and heat gains due to infiltration and conduction through floors, ceilings, windows and walls;
- ....an analysis of existing insulation and ventilation and recommendations regarding the need for more or less of each;
- ....a full description of heating, cooling, hot water, lighting and appliance systems;
- ....a two year billing audit which considers fuel consumption and cost for space heating and cooling, domestic hot water, electrical equipment and other appliance systems;
- ....consultation with homeowner to recommend possible energy conservation opportunities, in order of priority, and the payback period on these investments.

Conduct an energy conservation workshop for community, professional and lay organizations, which includes:

- ....information on energy conservation methods (a breakdown of energy uses in the home, from largest to smallest, in terms of energy consumption and suggestions on how to cut down on usage);
- ....displays of different types of insulation with R-values on each and recommended usage according to specific need;
- ....displays of various types of weatherstripping and caulking and recommended usage of each;
- ....charts showing R-values on various materials and water usage in a typical home;
- ....general information on alternate energy sources;
- ....general discussions on energy related questions generated from the audience as a result of information presented.

PROJECT EFFECT -

TIME LINE



PROJECT EFFECT

CORE CURRICULUM

DIDACTIC INSTRUCTION (6 MONTHS)

SECTION 1 - General Background

Module		Hours
Mathematics Review		17
Basic Writing		9.5
Energy Overview		68.5
	Total	95

SECTION 2 - Technical Training

Module		Hours
Basic Graphics and Blueprint Reading		89
Building Materials		20.5
Electricity		14
Alternative Energy Sources (Solar and Wood)		24.5
Introduction to Cooling Systems		23
Introduction to Heating Systems		37
Insulation and Ventilation		18
Lighting Efficiency		20
	Total	246

SECTION 3 - Energy Audit Preparation

Module		Hours
Energy Cost Calculations		16.5
Energy Use Survey: Procedure and Techniques		46
	Total	62.5

SECTION 4 - Community Education

Module		Hours
How to Conduct Community Energy Education Projects; Small Group Dynamics; Use of media, etc.		97
Demography and Survey Skills		38
The Organization of State and Local Government		14
	Total	149

PROJECT EFFECT

CORE CURRICULUM

PRACTICUM (2 MONTHS)

		Hours
SECTION I - Field Observations		24
SECTION II - Community Education (Workshops)		12
SECTION III - Energy Use Surveys		111
SECTION IV - Miscellaneous Activities Independent Worktime Placement and Critique Testing and Graduation		49
	Total	196
	+ 6 month didactic	552.5
	Complete Training Program =	748.5

PROJECT EFFECT

MONTHLY HOURS OF PROGRAM CONTENT (1978 - 79)

DIDACTIC PHASE

MODULE	DEC	JAN	FEB	MAR	APR	MAY	TOTAL HOURS
AREA I - GENERAL BACKGROUND							
Mathematics Review	3	8	6				17
Basic Writing	3	5.5	1				9.5
Energy Overview	11	35.5	12.5	9.5			68.5
AREA II - TECHNICAL TRAINING							
Graphics and Blueprint Reading	9	34	24	22			89
Building Materials		6	13.5	1			20.5
Electricity			9	5			14
Alternative Energy Sources (Solar and Wood)			24.5				24.5
Introduction to Cooling Systems						23	23
Introduction to Heating Systems					37		37
Insulation and Ventilation				9	9		18
Lighting Efficiency				2.5	17.5		20
AREA III - ENERGY AUDIT PREP.							
Energy Cost Calculations					8.5	8	16.5
Energy Survey						46	46
AREA IV - COMMUNITY EDUCATION							
Community Education	46.5	8	4.5	5	15	18	97
Demography and Survey Skills		10.5	13.5	14			38
State and Local Government				4	10		14
TOTALS	72.5	107.5	108.5	72	97	95	552.5

PROJECT EFFECT

PRACTICUM HOURS PER WEEK (JUNE - JULY, 1979)

	1	2	3	4	5	6	7	8	Module totals
FIELD OBSERVATIONS	15	3	3						21
COMMUNITY EDUCATION (WORKSHOPS)		3	9						12
ENERGY USE SURVEYS	6	15	6	24	18	24	24	18	135
MISCELLANEOUS: INDEPENDENT WORKTIME	6	6	6	3	3	3			27
PLACEMENT ACTIVITIES	4		4	3		3	3		17
TESTING AND GRADUATION							1	12	13
TOTAL CLASS HOURS	31	30	28	30	21	30	28	18	225

[redacted] DECEMBER [redacted] THROUGH JANUARY [redacted]

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK # 1	11 ORIENTATION 9-10 Intro and greetings - staff 10-12 Group Intro (Mosel) 12-1 Lunch 1-2:30 Logistics 2:30-4 Reception	12 9-12 Report Writing 11-12 Library Tour 1-2 Energy Pre-Test 2-4 Team Building (Mosel)	13 9-10:30 Algebra Review 10:30-12 Energy Overview 1-3:30 Energy Overview (Term Search)	14 9-12 Study Skills 1-4 Time Management Skills (Mosel)	15 9-11 Energy Overview 11-12 Community Education 1-3 Evaluation
WEEK # 2	18 9-12 Basic Graphics and Blueprints 1-2:30 Report Writing 2:30-4 Worktime	19 9-12 TABE TESTING at Goodwill Indust. 1-4 Energy Overview (Slide show)	20 9-12 Basic Graphics and Blueprints 1-2:30 Algebra 2:30-4 Worktime	21 9-10:30 Study Skills 10:30-12 Report Writing 1-3:00 Energy Overview	22 9-11 Basic Graphics and Blueprints 11-12 Comm. Ed. 1-3 Evaluation
WEEK # 3	25 CHRISTMAS	26 BREAK	27 ALL	28 WEEK	29 !!!
WEEK # 4	1 NEW YEARS DAY	2 9-10:30 Algebra Review 10:30-12 Report Writing 1-4 Energy Overview	3 9-11 Basic Graphics and Blueprints 11-12 Algebra 1-3 Energy Overview 3-4 Worktime	4 DAT TESTING ALL DAY	5 9-11 Basic Graphics and Blueprints 11-12:30 Demography 1:30-3:30 Evaluation

JANUARY 5 THROUGH FEBRUARY 2

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK # 5	8 9-11 Basic Graphics 11-12:30 Bldg. Mats. 1:30-3 Energy Overview 3-4 Worktime	9 9-12 Energy Overview (Twin Branch field trip) 1-2:00 Algebra 2:00-4 Comm. Ed.	10 9-11 Basic Graphics 11-12 Report Writing 1-3 Energy Overview 3-4 Worktime	11 9-12 Building Mats. 1-4 Demography	12 9--1 Basic Graphics 11-12:30 Demography 1:30-3:30 Evaluation
WEEK # 6	15 9-11 Basic Graphics Class dismissed after graphics	16 9-12 Energy Overview 1-2:30 Algebra 2:30-4 Comm. Ed.	17 9-11 Basic Graphics 11-12 Report Writing 1-3 Energy Overview 3-4 Worktime	18 9-4 Energy Overview (Field trip to Cook Nuclear Plant)	19 9-11 Basic Graphics 11-12:30 Comm. Ed. 1:30-3:30 Evaluation
WEEK # 7	22 9-11 Basic Graphics 11-12:30 Worktime 1:30-3 Energy Overview 3-4 Worktime	23 9-12 Energy Overview 1-2:30 Algebra 2:30-4 Comm. Ed.	24 9-11 Basic Graphics 11-12 Report Writing 1-3 Energy Overview 3-4 Worktime	25 9-4 Energy Overview 1-4 Demography	26 9-11 Basic Graphics 11-12:30 Demography 1:30-3:30 Evaluation
WEEK # 8	29 9-11 Basic Graphics 11-12:30 Bldg. Mats. 1:30-3 Energy Over view 3-4 Worktime	30 9-12 Energy Overview 1-2:30 Algebra 2:30-4 Comm. Ed.	31 9-11 Basic Graphics 11-12 Report Writing 1-3 Energy Overview 3-4 Worktime	1 9-4 Building Materials (Slide Show Presentation)	2 9-11 Basic Graphics 11-12:30 Demography 1:30-3:30 Evaluation

FEBRUARY 5 THROUGH MARCH 2

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK #9	5 9-11 Graphics 11-12:30 Bldg. Mats. 1:30-3:00 Energy Overview 3-4 Worktime	6 9-12 Energy Overview 11-12:00 Report Writing 1-2:30 Algebra 2:30-4 Comm. Ed.	7 9-11:00 Graphics 11-12 Electricity 1-3 Energy Overview (Solar)	8 9-12 Bldg. Mats. FIELD TRIP 1-4 Demography	9 9-11 Graphics 11-12:30 Demography 1:30-3:30 Evaluation
WEEK # 10	12 9-11 Graphics 11-12:30 Electricity 1:30-3 Energy Overview (solar) 3-4 Worktime	13 9-12 Energy Overview (solar) 1-2:30 Algebra 2:30-4 Comm. Ed.	14 9-11 Graphics 11-12:30 Electricity 1-3 Energy Overview (solar) 3-4 Worktime	15 SOLAR FIELD DAY (Rock Solar Home)	16 9-11 Graphics 11-12:30 Demography 1:30-3:30 Evaluation
WEEK # 11	19 9-11 Graphics 11-12:30 Electricity 1:30-3 Energy Overview (Solar) 3-4 Worktime	20 9-12 Energy Overview (solar) 1-2:30 Algebra 2:30-4 Demography	21 9-11 Graphics 11-12 Electricity 1-3 Energy Overview (Solar) 3-4 Worktime	22 9-12 Bldg. Mats. (Exam) 1-4 Demography	23 9-11 Graphics 11-12:30 Demography 1:30-3:30 Personal Interviews - Career Planning
WEEK # 12	26 9-11 Graphics 11-12:30 Electricity 1:30-3 (Wood) 3-4 Worktime	27 9-12 Energy Over view (Solar quiz) 1-2:30 Algebra (Exam) 2:30-4 Comm. Ed.	28 9-11 Graphics 11-12 Electricity 1-3 Energy Overview 3-4 Worktime	1 FIELD DAY (Bailly Power Plant)	2 9-11 Graphics 11-12:30 Demography 1:30-3:30 Evaluation

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK # 13	5 **********	6 **********S P	7 R I N G B R E A K	8 **********	9 **********
WEEK # 14	12 9-11 Graphics 11-12:30 Electricity 1:30-3 Energy Overview	13 9-12 Energy Overview 1-2 Comm. Ed. 2-4 Demography	14 9-11 Graphics 11-12 Electricity 1-3 Energy Overview (Hard-Soft Debate)	15 FIELD DAY GRAPHICS	16 9-12 Graphics SOUTH BEND ENERGY DAYS (SCOTTSDALE MALL)
WEEK # 15	19 9-11 Graphics 11-13:30 Electricity 1:30-3 Demography	20 8-11 Insulation 12-2 Energy Overview (final test) 2-4 Comm. Ed.	21 9-11 Graphics 11-12 Electricity (Exam) 1-3 State & Local Government	22 9-12 Insulation 1-4 Demography	23 9-12 Graphics 1-2 Job Readiness 2-3 Evaluation
WEEK # 16	26 9-11 Graphics 11-12:30 Lighting Demography cancelled	27 9-12 Insulation 1-2 Energy Overview 2-4 Comm. Ed.	28 9-11 Graphics 11-12 Lighting 1-3 State & Local Government	29 FIELD DAY (GRAPHICS)	30 9-12 Graphics 1-3 Evaluation

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PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK #17	2 9-11 Heating 11-12:30 Lighting 1:30-3 Cost Calculations	3 9-12 Insulation (Field trip) 1-4 Insulation	4 9-11 Heating 11-12 Lighting 1-4 Communications Skills (Mosel)	5 9-12 Insulation (Exam) 1-3 State & Local Government	6 9-12 Heating 1-3:00 Resume Writing
WEEK #18	7 9-11 Heating 11-12:30 Lighting 1:30-3 Cost Calculations	8 9-12 Heating 1:30-4 State & Local Government (Public Safety Hearing)	9 9-11 Heating 11-12 Lighting	10 HEATING FIELD DAY	11 9-12 Heating GOOD FRIDAY AFT. FREE
WEEK #19	16 9-10 Worktime 10:30-12 Lighting 1-3 Cost Calculations	17 9-12 Heating 1-4 Communication Skills (Mosel)	18 9-11 Heating 11-12 Lighting 1-3 State & Local Government	19 LIGHTING ANALYSIS SURVEY	20 9-12 Heating 1-3 Resume Writing
WEEK #20	23 9-11 Heating 11-12:30 Lighting 1:30-3 Cost Calculations	24 9-12 Building Codes 1-4 Comm. Ed.	25 9-11 Heating 11-12 Lighting 1-3 State & Local Government	26 HEATING FIELD DAY	27 9-12 Heating 1-3 Evaluation

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PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK #21	30 9-11 Heating 11-12:30 Lighting (Test) 1-3 Cost Calculations	1 9-12 Building Codes 1-4 Comm. Ed.	2 9-12 Heating 1-3 Energy Surveys	3 9-12 Cost Calculations 1-4 Comm. Ed.	4 9-12 Heating 1-3 Evaluation
WEEK #22	7 9-12 Heating (exam) 1-3 Cost Calculations	8 9-12 Bldg. Codes 1-4 Comm. Ed.	9 9-12 Cooling 1-3 Energy Surveys	10 9-12 Cost Calculations 1-4 Comm. Ed.	11 9-12 Cooling TO BE ANNOUNCED
WEEK #23	14 9-12 Cooling 1-3 Energy Surveys	15 9-12 Energy Survey 1-4 Comm. Ed.	16 9-12 Cooling 1-3 Energy Surveys	17 9-12 Energy Surveys 1-4 Comm. Ed.	18 9-12 Cooling 1-3 Evaluation
WEEK #24	21 9-12 Energy Surveys 1-3 Cooling (exam)	22 ENERGY SURVEYS	23 ENERGY SURVEYS	24 ENERGY SURVEYS	25 NO CLASSES

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MAY 31 THROUGH JUNE 22

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK # 25	28 MEMORIAL DAY	29 ENERGY USE SURVEY 1-4	30 9-4 COOLING	31 WRAP-UP	1 ORIENTATION TO PRACTICUM
WEEK # 26	4 TEAM A - SUPERVISED AUDIT TEAM B - OBSERVATIONS	5 TEAM A - OBSERVATIONS TEAM B - SUPERVISED AUDIT	6 TEAM A - WORKTIME TEAM B - OBSERVATIONS	7 TEAM A - OBSERVATIONS TEAM B - WORKTIME	8 NORTHERN INDIANA PUBLIC SERVICE CO. (GAS) WORKSHOP (ALL) BROWN BAG LUNCH JOB READINESS
WEEK #27	11 TEAM A - COMPUTER INSTRUCTION TEAM B - SUPERVISED AUDIT	12 TEAM A - SUPERVISED AUDIT TEAM B - COMPUTER INSTRUCTION	13 TEAM A COMPUTER INSTRUCTION TEAM B - WORKTIME	14 TEAM A - WORKTIME TEAM B - COMPUTER INSTRUCTION P.M. - DEMO AND PRACTIVE DELIVERING AUDIT TO CLIENT	15 INDIANA & MICHIGAN WORKSHOP (ELECTRIC CO.) DRESS REHERSAL - ENERGY CONSERVATION WORKSHOPS
WEEK #28	18 SEMI-SUPERVISED AUDITS (in teams)	19 OPTIONAL OBSERVATION - TEAMS A & B WORKTIME	20 WORKTIME DRESS REHERSAL - ENERGY CONSERVATION WORKSHOPS	21 TEAM A - WORKSHOP AT "ACTION, INC" TEAM B - WORKSHOP AT "ACTION, INC." (evening)	22 CATCH-UP BROWN BAG LUNCH JOB READINESS

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PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK #29	25 START - ASSESSMENT OF AUDIT PERFORMANCE SEMI-SUPERVISED AUDITS	26 SEMI-SUPERVISED AUDITS	27 SEMI-SUPERVISED AUDITS	28 SEMI-SUPERVISED AUDITS	29 WORKTIME JOB READINESS
WEEK #30	2 INDEPENDENT AUDIT ASSESSMENT	3 INDEPENDENT AUDIT ASSESSMENT	4 INDEPENDENCE DAY NO CLASSES	5 INDEPENDENT AUDITS	6 WORKTIME JOB READINESS
WEEK #31	9 INDEPENDENT AUDITS	10 INDEPENDENT AUDITS	11 INDEPENDENT AUDITS	12 INDEPENDENT AUDITS	13 WORKTIME JOB READINESS
WEEK #32	16 INDEPENDENT AUDITS	17 INDEPENDENT AUDITS	18 INDEPENDENT AUDITS	19 INDEPENDENT AUDITS	20 ENERGY POST-TEST JOB READINESS

PROJECT EFFECT - CURRICULUM CALENDAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK # 33	23 INDEPENDENT AUDITS	24 INDEPENDENT AUDITS	25 INDEPENDENT AUDITS	26 DIFFERENTIAL APTITUDE TEST (DAT'S) ALL DAY	27 GRADUATION!!!
WEEK #					
WEEK #					
WEEK #					

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SECTION 2 - TECHNICAL TRAINING

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INTRODUCTION - SECTION II

Technical Training

MODULES:

Alternative Energy Sources (Solar and Wood)

Basic Graphics and Blueprint Reading

Building Materials

Electricity

Introduction to Cooling Systems

Introduction to Heating Systems

Insulation and Ventilation

Lighting Efficiency

This comprises the bulk of the curriculum and builds on the Introductory Modules in Section 1. The modules are timed to follow and/or coincide with one another in a logical fashion so that each module builds on the ones before or is taught in conjunction with related modules. Wherever possible, field trips, observations and practical experiences are built into the instruction. Instructional faculty and visiting lecturers are brought in from the professional and business community wherever appropriate in order to keep a realistic, practical focus at all times.

ALTERNATIVE ENERGY SOURCES (SOLAR AND WOOD) 24.5 HOURS

The increasing price of fossil fuels is helping to make non-traditional sources of energy look very appealing in terms of helping to meet our energy needs. There currently appears to exist a rather large gap between people's image of solar energy's potential and the reality of that potential. In an effort to bridge that gap the Solar and Wood module is designed to give the student a basic understanding of two renewable sources of energy, so that they will be able to advise homeowners as to the practicality of purchasing such equipment for their homes.

PRE-REQUISITES: Mathematics Review, Energy Overview, Basic Graphics Module(desirable)

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: 8th grade

Dexterity: N.A,

Spatial Orientation: Read schematics and blueprints (desirable)

ALTERNATIVE ENERGY SOURCES (SOLAR AND WOOD)

OBJECTIVES

1. Discuss the sun and its relationship to the earth and its inhabitants.
2. Explain the basic advantages and disadvantages of using solar energy as a fuel source for domestic space and water heating.
3. Discuss and explain the principles & methods of collecting, storing and distributing solar energy.
4. Discuss and explain the principles and methods of using wood as an energy source.
5. Advise consumers on how to soundly invest in solar and wood heating equipment.
6. Discuss the role of legislation in promoting the use of renewable sources of energy.

RESOURCES

HANDOUTS

1. Glossary in Solar Home Book, pp. 292-293
2. Appendix from Solar Home Book, p. 259
3. Solar Home Book, pp. 80, 82-88, 93, 116, 123, 131, 142, 145, 150-151, 166, 172, 175-177, 179, 181, 220, 287
4. Solar Home Book pp. 94, 142, 145, 172, 176-180, 185-187, 190-196
5. Solar Home Book pp. 204, 205, 218

BOOKS AND REFERENCES

1. Direct Use of the Sun's Energy, Farrington Daniels, Ballatine, 1964, chapters 1, 2, 3, 4, 6, 8, 9, 12
2. The Solar Home Book, Bruce Anderson, Cheshire Books, 1976, entire book
3. Low-Temperature Engineering Applications of Solar Energy, Jordan, pp. 259, 266-70
4. Buying Solar, Federal Energy Administration and Office of Consumer Affairs, HEW, June 1976
5. The Woodburner's Encyclopedia, J. Shelton, Vermont Crossroads Press, Waitsfield, VT
6. National Energy Plan I
7. Elements of Climatology, Glenn Trewartha

ALTERNATIVE ENERGY SOURCES (SOLAR AND WOOD) SYLLABUS

Session #	Hours	Objectives	Topic
1	2	1,2	Introduction to solar energy and Physics of the sun - Solar energy and the Second Solar Constant - Law of Thermodynamics - Advantages and Disadvantages of solar energy - Handouts # 1 and 2
2	1.5	1	Weather patterns and general climatology - Factors of solar constant
3	3	2,3	Methods of collection - Advantages and Disadvantages of solar energy - Principles of collecting, storing and distributing solar energy - Handout #3
4	2	2,3,5,6	Storage and principles of common materials (water, rock, concrete, etc.) - Handout #4 - Prepare for field trip
5	5	2,3,5,6	Field trip to solar home - Collection of data to interpret principles of Session 4
6	1.5	2,3,5	Discuss field trip - Explain estimating collector size - Basic rule for checking performance of a collector - Explain storing, collecting and sizing of SHB - Basic rule of solar domestic hot water - Handouts #4,5
7	3	2,3,5	Review materials from Session 6 - Discuss Handout #5 - Explain heat capacity problems - Discuss cost effectiveness of solar equipment installation
8	2	2,3,5,6	Review domestic water heating problems and lecture content - Principles of buying solar - Relationship of current legislation and solar usage/installation - Handouts #4,5

SYLLABUS

ALTERNATIVE ENERGY SOURCES (SOLAR AND WOOD) CONTINUED

Session #	Hours	Objectives	Topic
9	1.5	4,5,6	Discuss wood as an energy source, as a fuel and the different types - BtU values, densities and moisture content of various woods - Explain combustion process of wood - Role of oxygen and temperature to secondary combustion - Discuss BtU on stoves - Explain proper installation of woodburning stoves and local fire codes - Causes and prevention of cresscressote - Cost of burning wood - Tax credit on woodstoves
10	3		Exam

PROJECT EFFECT

Energy Overview - Solar and Wood Quiz

PART I (50 points)

From the list provided below choose the proper term or number that best fills in the blank. You are allowed to use the same answer more than once. Answers are not necessarily grammatically correct in relation to the rest of the sentence.

above	heat trap	thermal mass
absorber	heliostat	thermosiphoning
absorbs heat	high	thickness
absorptance	hour of day	time of day
active	indirect	trapping heat
air gap	integrated	turbulent
albedo	irregular	umbrella
area	latent heat	volume
below	latitude	weight
Btu output	north	west
clarity of atmosphere	ozone	windows
creosote	passive	0, ¼, ½, 1, 2, 3,
Dark paint	placement	10, 30, 35, 40, 41, 45,
day of year	pyranometer	50, 54, 56, 57, 60, 65,
degree days	radiation	90, 128, 200, 240, 330, 2200,
density	reflects heat	3000, 4000, 8000, 10000, 30000,
direct	releases heat	40000, 100000, 200000
doors	season of year	
east	selective surface	
efficiency	solar collector	
emittance	solar constant	
flatplate	solarometer	
fresnel lens	south	
greenhouse	specific heat	
heat capacity	sunny days	
heat storehouse		

1. In the upper latitudes (greater than 40^0 N), South sides of houses receive nearly _____ as much solar radiation in winter as in summer.

2, 3. The most significant factors in capturing the sun's energy for direct solar heating of a home are the size and _____ of _____.

4. In most areas of the U.S. , double clear glass windows on the _____ side provide optimum winter heat gain.

5. The amount of solar radiation striking the outer atmosphere of the earth is known as _____.

6. We say that massive houses, whose indoor temperatures do not respond quickly to fluctuations of outdoor temperature have a large _____.

7, 8, 9. When designing a house to make optimum use of direct methods of collection of solar energy, one should try to make the house act as a _____, _____, and _____.

10. The natural physical movement of heat through a fluid, occurring when a warmer fluid rises and cooler fluid sinks, is known as _____.

11, 12, 13, 14. The maximum solar radiation striking one square foot of the earth's surface is _____ Btuh/ft^2. This figure depends on five factors. List any three:

_____, _____, and _____.

15. The latitude of South Bend, Indiana is _____ ^{0}N.

16, 17. Any material _____ as its temperature rises and _____ as its temperature falls.

18. An instrument for measuring solar radiation is _____.

19. _____ is a special coating sometimes applied to the absorber plate in a solar collector. This coating absorbs most of the incoming solar energy and reradiates very little of it.

20, 21. Techniques of solar heating in which sunlight enters a house through the windows and is absorbed inside are known as _____ or _____ methods.

22. The type of solar collector that works best for the climate of South Bend is the _____ collector.

23. As a general rule of thumb, if a collector has a selective surface, it should have _____ cover plate(s).

24. When using polyurethane as insulation in a collector it is important to remember to have a _____ between the back of the absorber plate and the insulation.

25. The optimum collector tilt for solar space heating at South Bend's latitude is _____°.

26. The optimum collector tilt for solar domestic water heating at South Bend's latitude is _____°.

27, 28. Techniques of solar heating or cooling in which the solar heat is collected exterior to the building and transferred inside using ducts or piping and, usually, fans or pumps, are known as _____ or _____ systems.

29, 30. In an air-type flat plate collector, it is desirable to have a _____ flow of air across the absorber and a _____ surface for the absorber.

31. In a rock storage bin there is usually a _____ % void space between the rocks.

32, 33. The location of a rock storage bin must take into account its great _____ and _____.

34. If 1,000 pounds of water can store 20,000 Btu's as its temperature increases from 80° F to 100°F, how many Btu's can it store from 80° F to 120° F? _____

35. It is better to describe the heat storage capacity of a solar system as the number of _____ of heating demand that a system can provide.

36. If 500 square feet of collectors can provide 50% of a house's heat, then 1,000 square feet should be able to provide 100%.
True or False (circle one).

37. In general, with a solar domestic hot water heater, one square foot of collector should be able to provide at least _____ gallon(s) of hot H_2O per day.

38. The number of Btu's needed to raise the temperature of one pound of a material 1° F is called the _____ of a substance.

39. The number of Btu's that can be stored in one cubic foot of a substance over a temperature use of 1° F is called the _____ of a substance.

40, 41, 42. The Rock Solar home has _____ square feet of collectors for space heating, _____ square feet for domestic hot water, and a _____ gallon storage tank.

43. A good seasonal output for one square foot of a solar collector would be _____ Btu's per year.

44. A realistic overall seasonal efficiency for a good flat plate solar collector would be about _____ %.

45. When venting a woodstove into the same chimney as a gas or oil furnace, the woodstove should be vented _____ the vent of the furnace.

46, 47, To determine how much heat a woodstove can provide for a home, one needs to know the _____ and _____ of the stove.

48. When using a woodstove, a substance that can build up inside the chimney and possibly ignite is _____.

49. The Btu content of a pound of air-dried wood is approximately _____.

50. A cord of wood usually has about _____ cubic feet of solid wood in it.

Project EFFECT -
Energy Overview - Solar and Wood Quiz
Page 5

PART II Please show all work, as only partial credit will be given for answers only.

1) 20 points

Given: Chart below
Heat Loss/Degree Day 10,500 Btu

Find: The appropriate answers to the numbered blanks
The number of square feet of collectors needed to provide close to (±5%) 50% of the heating load.

	Collector Output But/ft	Degree Days F-days	Heat Loss MBtu	Solar heat Collected MBtu	Aux. Heat MBtu	Solar heat Used MBtu	% Solar Heated
Sept.	16,400	125	1.31	7.26	0	(1)	100%
Oct.	13,900	401	4.21	6.15	(2)	4.21	100%
Nov.	9,800	766	(3)	4.34	3.70	4.34	(4)
Dec.	8,600	1248	13.10	3.81	(5)	3.81	29%
Jan.	8,700	1382	(6)	(7)	(8)	(9)	(10)
Feb.	10,200	1234	12.96	4.52	8.44	4.52	35%
Mar.	12,500	1074	11.28	(11)	5.75	5.53	49%
Apr.	10,700	652	6.85	4.74	2.11	4.74	69%
May	10,900	264	2.77	4.82	0	(12)	100%
Totals	(13)	7146	75.03	(14)	39.95	(15)	(16)

(17) _____ square feet of collectors will provide (18) _____ of the heating demand.

Solve one of the following two problems. Please show all work, as only partial credit will be given for answers only.

2) (15 points) A house designed for passive solar heat collection has a Trombe wall facing south that measures 10 feet by 50 feet by 6 inches thick. At 7 p.m. on a particular day, the temperature of the wall is 80° F. From that time until 10 a.m. the next morning, the outdoor temperature averages 15° F., while the indoor air averages 65°F. If the house loses heat at a rate of 450 Btu/hr/°F, and there is no auxiliary source of heat, what is the temperature of the wall at 10 a.m. the next morning?

3) A. (15 points)

1. How much heat can a cubic foot of water store over a 45°F temperatute rise?

2. How many gallons of water are needed to store 250,000 Btu over a 45°F temperature rise?

3. How much would this amount of water weigh?

B. 1. How much heat can a cubic foot of rock store over a 45°F temperature rise?

2. How many cubic feet of rock are needed to store 250,000 Btu over a 45°F temperature rise?

3. How much would this amount of rocks weigh?

4. How much space would a storage bin this size take up?

BASIC GRAPHICS AND BLUEPRINT READING 89 HOURS

Scheduled at the beginning of the program, this module is designed to provide the tools required to inspect, observe and report details of structures by learning how to represent observations in a draftsman-like form. The student must learn the proper names for building components and the basic concepts of how a structure is assembled. The ability to take and record measurements, calculate dimensions and reduce to scale helps facilitate learning in later modules. The students also learn to read and interpret blueprints of residential and light commercial structures, with particular emphasis on location of doors, windows, heating and cooling systems and electrical outlets.

A minimum of lecturing takes place in this unit. Instead, the students practice drawing representations of structures from a variety of perspectives, ranging from a very simple one story residence to a representation of the I.U.S.B. Administration Building.

PRE-REQUISITES: N.A.

Writing level: N.A.

Math level: Calculate square feet, volume, add dimensions, scale conversion

Dexterity: Use drafting tools

Spatial Orientation: Layout of plans, centering, visualization of components

GRAPHICS AND BLUEPRINT READING

OBJECTIVES

1. Understand and use scale in reduction and blow-ups of sketches and drawings.
2. Recognize, understand and draw standard plan symbols.
3. Use drafting equipment effectively and properly.
4. Understand and draw sectional views.
5. Draw to scale floor plans and elevations of buildings.
6. Calculate areas and volumes of buildings.
7. Recognize and understand the functions of building materials.
8. Understand and perform dimensioning.
9. Use good lettering skills.
10. Make accurate sketches and drawings of observations.

RESOURCES

HANDOUTS

1. Floor plan, dimension, area, grid paper
2. Reverse plan
3. Line symbols, guide lines, pencil types, drafting kits
4. Rules for lettering
5. Sequence of drawing floor plans
6. Floor plan
7. 24 Dimension Rules - Fig. 26-2
8. Projecting elevations - Fig. 28-3
9. Plan Symbols
10. Roof types - Fig. 27 - 22B
11. Calculation form
12. 3 pages transverse sections

BOOKS AND REFERENCES

1. General Source: Architecture Drafting Design, 2nd ed., Helper and Wallach, McGraw-Hill Pub.
2. Heat Loss Calculation form: Modine Manufacturing Co., 1500 Dekoven Ave., Racine, WI 53401, Heating and Air Conditioning Division
3. Drawings and blueprints of IUSB buildings.

GRAPHICS AND BLUEPRINT READING SYLLABUS

Session #	Hours	Objectives	Topic
1	3	1 - 10	Introduction of objectives - Examples of architectural drawings - Explanation of grid paper - Simple one line sketch in class on grid paper - Exercise #1
2	3	1,5,6	One line sketch of floor plan on grid paper - Indicate dimensions and area - Draw reverse plan - Exercise #2
3	2	1,2,6	Module measuring - Assignment: Measure own house
4	2	1,5,6,10	Use module measuring (in teams of 3) to get measurements and draw floor plans on grid paper of IUSB building
5	2	1,5,6,10	Same as Session 4 - Exercise #3
6	2	1,5,6,10	Use measurements of own house to draw in class floor plans on grid paper - Exercise #4
7	2	2,3	Types of lines, symbols, lettering - Learn to use drafting instruments from kit
8	2	9	Lettering rules - Practice
9	2	9	Practice lettering - Exercise #5
10	2	3,9,10	Practice lines from Object lines to Guide-lines - Practice lettering - Exercise #6
11	2	3,5	Use of architect's scale - Test #1 Line Symbols
12	2	1,3,5	Draw 2 line floor plan on vellum from handout - Exercise #7 using scale: 1/4" = 1'0"

GRAPHICS AND BLUEPRINT READING CONTINUED

Session #	Hours	Objectives	Topic
13	2	8	Rules for Dimensioning (24) - Handout - Assign: any scale drawing - Exercise #8 - Using handout dimensions
14	2	1,5,10	Practice drawing to any scale - Exercise #8 from handout - Continue Session 13
15	2	1,5,10	Same as Session 14 - Exercise #8
16	2	1,5,10	Same as Session 15 - Exercise #8
17	2	5,8	Test #2 on Dimensioning Rules - Begin "Elevations" - Exercise #9
18	2	2,5	Learning Plan Symbols - Learning to draw elevations - Exercise #9
19	2	2,5	Same as Session 18 - Exercise #9
20	2	2,5	Same as Session 19 - Exercise #9 - Handout Roof Types (2 pages)
21	2	2,5	Plan symbols, elevations - Exercise #9
22	2	2,6	Relate drawings to residence seen on field trip
23	2	4,5,8	Roof types - Draw plan view and elevation of different roof types - Exercise #11
24	2	4,5,8	Same as Session 24 - Exercise #11
25	2	2,7	Draw and learn symbols for Materials - Handout: "Symbols" - Exercise #12
26	2	2,7	Learn and draw window and door types - 5 page handout - Exercise #13

GRAPHICS AND BLUEPRINT READING CONTINUED

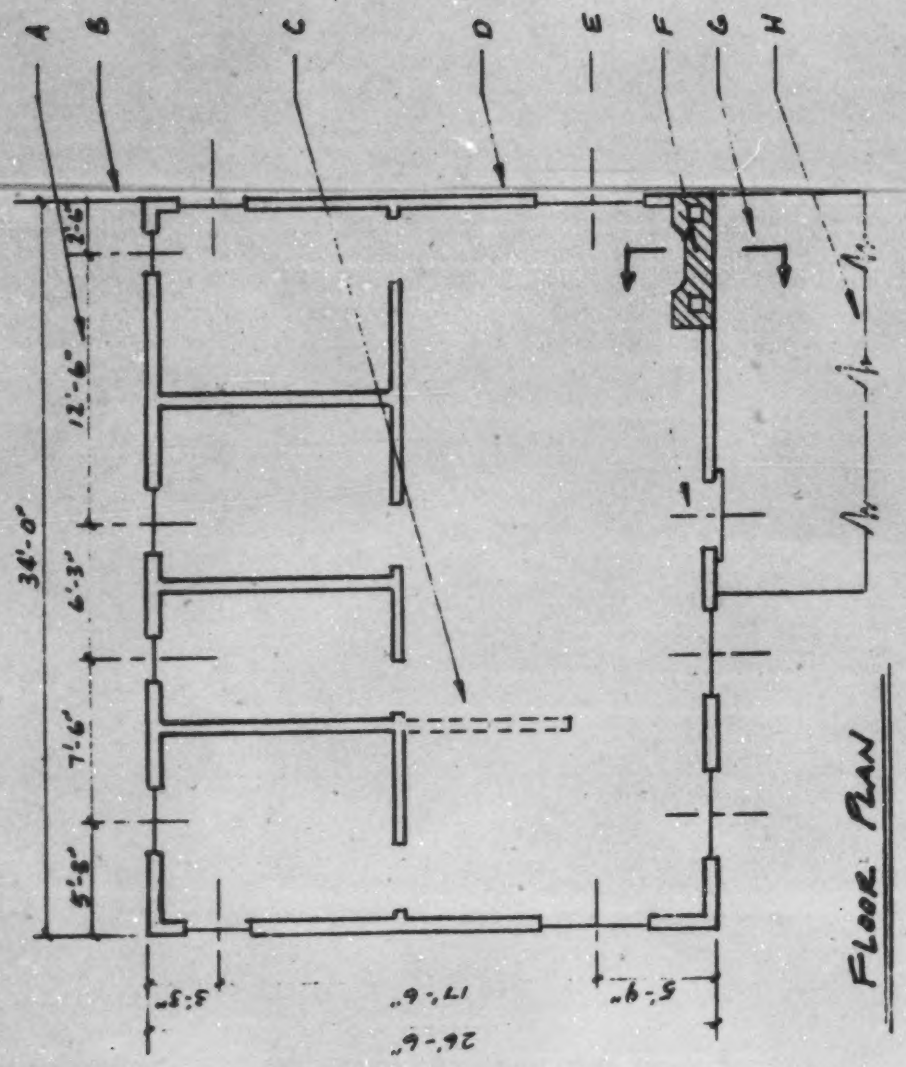
Session #	Hours	Objectives	Topic
27	2	2,7	Same as Session 26
28	2	2,7	Continue Exercise #13 (Windows and Doors)
29	2	2,5	Practice "one-line" drawings from detailed plans - Exercise #14 - Four elevations
30	2	5,6,10	Prepare for field trip to measure buildings on campus
31	5	5,6,10	Field Day
32	3	2,7	Test #3 - Identify roof and window styles - Transverse section of a house - Exercise #15
33	2	4	Transverse Section of Rock Solar Home - Exercise #16
34	2	1,2,5,7	Recognize symbols and read blueprints (Small groups) - Exercise #17
35	3	1,2,5,7	Recognize symbols and read blueprints (Small groups)
36	2	1,2,5,7	Blueprints of buildings
37	2	1,2,5,7	Blueprints of IUSB buildings - Exercise #18
38	5	1 - 10	Field Day - Cole Associates Architectural Firm
39	3	1 - 10	Complete basic blueprints and graphics - Worktime

BASIC GRAPHICS

Project EFFECT IUSB

Test #1

Identify A-H



FLOOR PLAN

SCALE: ½" = 1'-0"

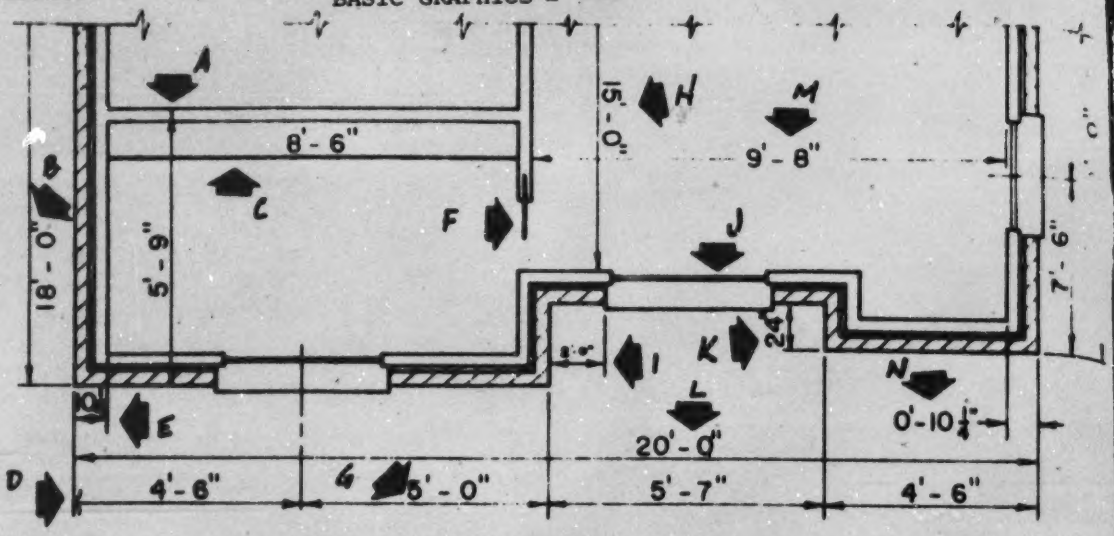
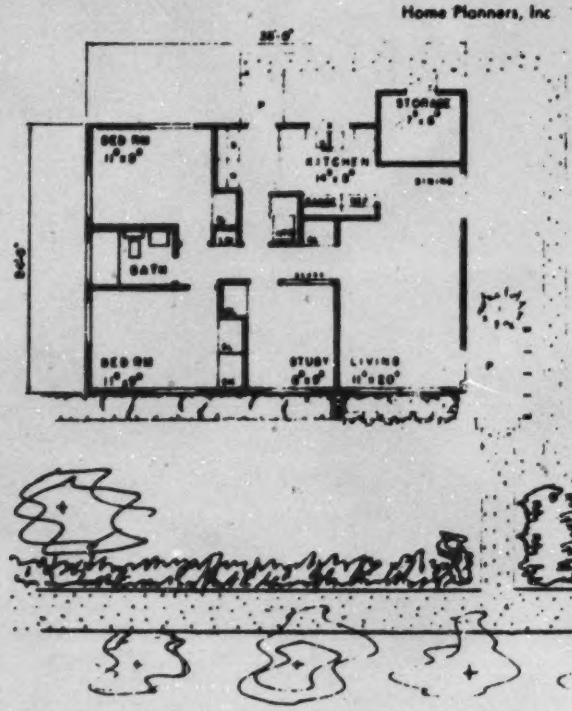


Fig. 26–10. Find the dimensioning errors shown by the letters.

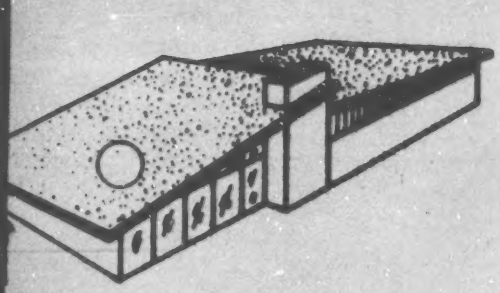
Fig. 26–11. Draw a floor plan of this house complete with dimensions.



3. Dimension the floor plan shown in Fig. 26–i by the modular method.
4. Find the dimensioning errors in Fig. 26–10. Lis the dimensioning rule violated in each case (Example: L violates rule 7.)
5. Draw and dimension the floor plan of your own home.
6. Sketch or draw the floor plan found in Fig 26–2 and change dimensions to modular di mensions. Use dots for non-grid lines and arrowheads for grid lines.
7. Sketch or draw the floor plan shown in Fig 26–11 and completely dimension your plan
8. Define the following terms: *dimension line fractional dimensions, overall dimensions, center lines, extension lines, leader lines, subdimen sions, framing dimensions, modular dimension ing, grid dimensions, non-grid dimensions.*

IDENTIFY ROOF & WINDOW STYLES - Test #3

2-20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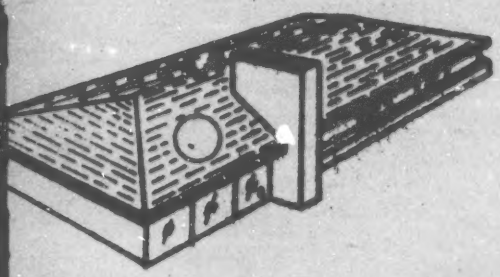
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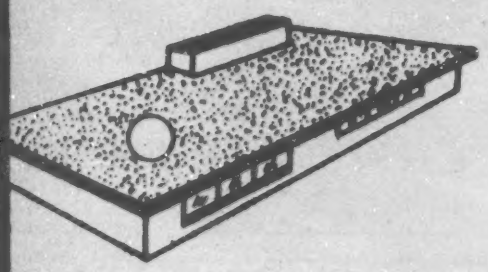
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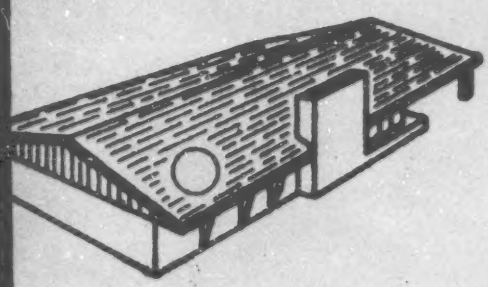
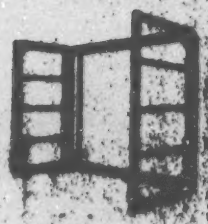
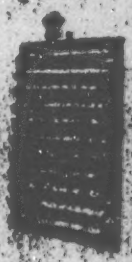

4.

5.

6.


7.



9.

10.

11.

13.

14.

HOPPER	PROJECTED
JALOUSIE	CASEMENT
STORM-SCREEN	DOUBLE HUNG
AWNING	SINGLE HUNG
SLIDING	SKYLIGHT

BUILDING MATERIALS 19.5 HOURS

It is essential that an energy technician understand the basic components of buildings and the properties of building materials in order to assess the efficiency of energy use for space conditioning within the thermal envelope and make recommendations for change consistent with local building codes.

Knowing the vocabulary of building terms is necessary to communicate effectively with professionals in the building trade.

Field trips to both older and newer homes as well as homes under construction help the students understand the history of building techniques.

PRE-REQUISITES: Blueprint Reading

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: 8th grade

Dexterity: N.A.

Spatial Orientation: Ability to read blueprints and two and three dimensional drawings

BUILDING MATERIALS

OBJECTIVES

1) Describe the basic components of buildings.

2) Explain the factors influencing choice of materials including: occupancy/purpose, costs, climate, availability and trends in construction, aesthetics/appearance.

3) Describe types of materials and appropriate usage.

4) Describe construction techniques relating to specific materials and components.

5) Discuss and explain perspectives and trends in residential building construction.

RESOURCES

HANDOUTS

1) "Glossary of building terms" and "Typical window and door construction"
2) "Resistance values of structural and finish materials, insulations, air spaces, and surface films" and "Page of examples of such materials"
3) "Framing, sheathing and insulation - Characterics of wood", "Framing, sheating and insulation - Floor joists", "Framing, sheathing and insulation - Types of house framing"
4) "Roof framing - Types of roof framing"
5) "Illustration of outswinging casement sash"

BOOKS AND REFERENCES

1) Framing, Sheathing and Insulation, Raymond P. Jones, VanNostrand Reinhold Publishing Co., New York, NY, 1973.
2) Uniform Building Codes, International Confederate of Building Officials, publishers, Whittier, CA, 1978.
3) National Fire Codes - Recommended Practices and Codes, National Fire Protection Association, publishers, Boston, MA, 1977
4) National Electrical Codes 1978, National Electrical Contractors Association, publishers, Washington, D.C., September 1, 1977.
5) One and Two Family Dwelling Code 1976 Edition, The Administrative Building Council of Indiana, publishers, Indianapolis, IN, June 24, 1976.

BUILDING MATERIALS SYLLABUS

Session #	Hours	Objectives	Topic
1	1.5		Introduction to Building Materials - outline objectives
2	3	2,3	Properties of materials
3	1.5	1,4	Building components: foundations, floor framing
4	6	1,4,5	Building components (cont.): floor framing, wall framing, ceiling and roof framing. Guest lecturer - History of building materials: how techniques have changed and experiences in rehabiliatation
5	1.5	1,2,4	Wall sheathing, exterior covering, roofing materials, interior finishes
6	3	1,2,3,4,5	Field trip - older homes, new homes
7	3	1,4	Windows and doors (one hour). Final examination (two hours)
8	1	1-5	Guest lecturer: Randy Landsberg, Director of Campus Engineering IUSB, "State and Local Building Codes"

PROJECT EFFECT
Building Materials Exam
February 22, 1979 paf

Part I (60 pts.)

From the list provided below, choose the proper term for each of the building components labelled 1 through 30 on the two attached diagrams. Write each answer in the corresponding blank space provided.

Beam (or Girder)
Blocking
Bridging
Building paper
Concrete Slab
Cornice
Double Stud
Draintile
Frieze Board
Footing
Foundation Wall
Gravel Fill
Header Joist
Interior Finish
Joists
Lintel
Louver
Molding
Posts
Rafters
Roll Roofing
Roof Covering
Ridgeboard
Siding
Sheathing
Sill Plate
Sole Plate
Studs
Subfloor
Top Plate
Valley Rafter
Waterproofing

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____

2-25

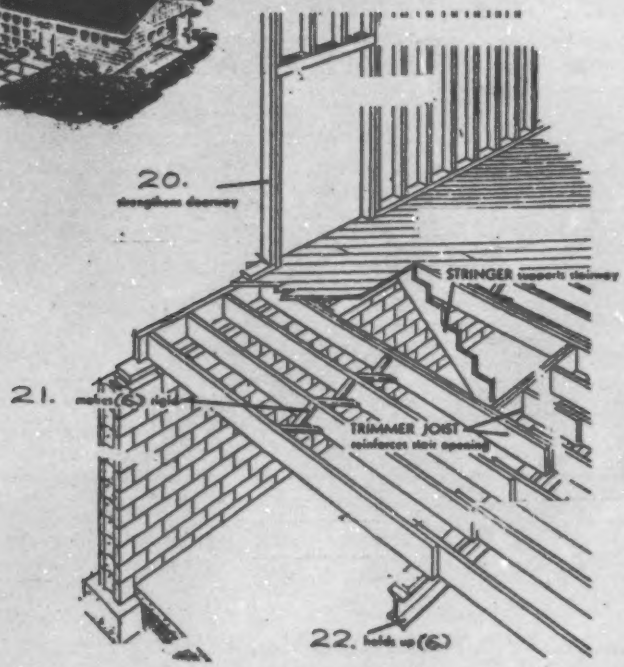
A glossary of building terms

Foundation to top of wall is shown in this drawing

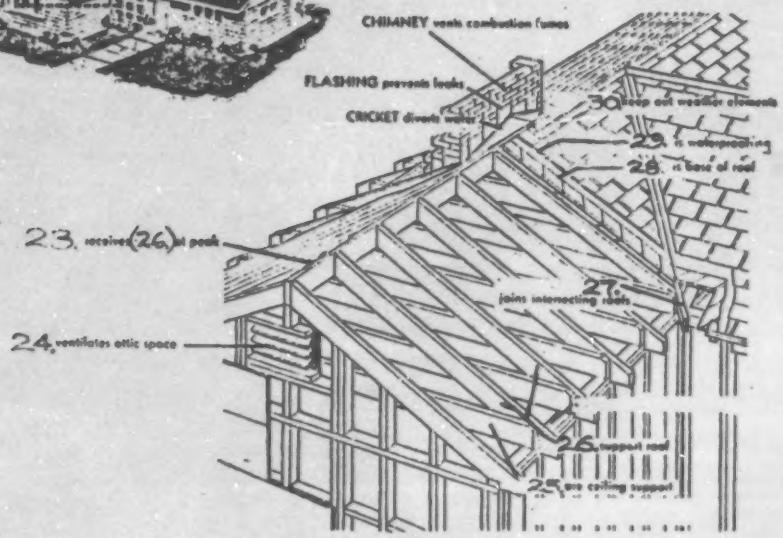
1. carries ceiling, roof
2. are wall's "skeleton"
3. spans opening
4. takes sheathing nails
5. strengthens floor
6. hold up floor
7. keeps floor dry
8. carries off water
9. bears up (11)
10. is basement floor
11. supports house
12. prevents seepage
13. is bearing for (6)
14. seals (6) ends
15. carries (2)
16. is strength, insulation
17. is air seal
18. keeps out weather elements
19. covers inside of (2)

Building terms *continued*

Here's the way lumber becomes walls and floors in a house



See how the roof goes together



Part II (40 pts.)

Fill in the following blanks 31 through 50 with the best answer from the list provided below:

ASTM (American Society for Testing and Materials)
ASHRAE (American Society of Heating, Refrigeration & Air Conditioning Engineers)
Balloon Framing
Bevel
Built-up roofing
Cornice
Crawl Space
Drywall
Fenestrations
Gypsum Board
Gable
Joists
Truss
Fiberboard
K-Value
Lath
Masonry Veneer
Materials Specification
Nominal Size
Performance Specification
R-Value
Sweets Catalog File
Studs
Sill Sealer
Shingles
Sheathing
Slab on grade
Subfloor
Thermal Expansion
U-Value

31. _____ is a set of criteria which a builder must meet in selecting construction materials for a job.

32. _____ consists of several volumes of technical advertising literature and is an excellent source of information about building materials.

33. _____ is an organization engaged in the standardization of specifications and testing methods for building materials. It publishes a 48-part set of over 400 standards covering design, manufacture, construction and maintenance of materials.

34. _____ is the combined thermal value of all the materials in a building section, air spaces and surface air films, expressed in Btu/hr/sq. ft./^{o}F. This property increases as the density of materials increases.

35. _____ refers to the ability of a material to become longer when heated. It is expressed in inches per inch per ^{o}F or cm. per cm. per ^{o}C.

36. _____ are vertical wall framing members, normally consisting of 2 x 4 in. lumber, spaced 16 inches apart.

37. _____ is the type of wood frame construction most often used for homes with two or more stories. It is characterized by studs which rest on the sill plate and extend to the roof line.

38. _____ is a method of foundation construction which is similar to a full basement except that no excavation is required between the foundation walls and no concrete floor is provided.

39. _____ should be used under the sill plate on top of foundation walls to prevent air infiltration where the wood and masonry meet.

40. _____ is a method of exterior wall finish where a layer of brick, stone or cement plaster (stucco) is used instead of aluminum or wood siding over the sheathing.

41. _____ two-inch boards are actually only 1½ inches thick.

42. _____ refers to the use of sheet materials such as gypsum board, wood paneling, plywood or fiberboard for interior finish instead of plaster.

43. _____ is a term applied to openings in a wall, such as windows or doors.

44. _____ must be applied diagonally or at right angles to the joists, and extends to all edges of the building in platform construction.

45. _____ consists of several layers of bituminous (tar or asphalt coated) felts normally applied only to "flat" roofs.

46. _____ is the projection of the roof at the eaveline that forms the connection between the roof and sidewalls. Types are open, closed or "box."

47. _____ is an assembly of members forming a rigid framework of triangular shapes used as a roof support instead of rafters.

48. _____ refers to the material used for a base upon which plaster is applied, most commonly wood, gypsum, fiberboard or metal.

49. _____ is the least dense sheathing material. Consequently, it provides the greatest insulating value and the least structural strength.

50. _____ is a list of construction materials which the builder must use for a job

ELECTRICITY 14 HOURS

It is essential that an energy technician have a sound, practical understanding of the principles of electricity and electrical wiring in order to assess energy use and make recommendations for change consistent with electrical safety requirements. While its uses vary, the relative electrical energy load in a residence or light commercial structure, can range from lighting only to operation of all energy systems (lighting, heating, cooling, hot water and equipment).

This highly technical module requires mastery of a new professional vocabulary and unfamiliar sets of concepts. In a laboratory setting, trainees observe the intricacies of electrical circuitry and equipment with wiring systems. They learn the role of electricity in the function of basic mechanical devices and special emphasis is placed on the importance of considering the energy efficiency ratings of electrical equipment.

PRE-REQUISITES: Mathematics Review and Blueprint Reading

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: Basic algebra (Ohm's law)

Dexterity: Use of meters and making electrical connections

Spatial Orientation: Read blueprints - locate electrical outlets, switches

RESOURCES

HANDOUTS

1. Fundamentals of Electricity
2. Common Electrical Terms and Measures
3. Dimensions of Wire/Allowable Carrying Capacities of Conductors
4. Present Electric Rates/Cost of Electricity vs. Usage
5. Electrical Controls
6. Electric Heat
7. Sears Catalog Pages (See Lighting Module)
8. Glossary of Electrical Terms
9. Energy and the Environment

BOOKS AND REFERNECES

Handyman, Bariner Press, New York, NY, pp. 389-420, pp. 99-116, pp. 303-345

Underscanding and Using Electricity, McKenzie and Zachariah, Interstate Printers, Danville, IL

ELECTRICITY

OBJECTIVES

1) Explain the difference between insulators and conductors with examples.

2) Discuss and compare the relationships between resistance, length, and cross-sectional area of conductors.

3) Explain the relationship between voltage, current, resistance, electric power and energy, and their respective units.

4) Explain the difference between A.C. and D.C. and A.C. generation.

5) Demonstrate understanding of residential 3-wire, 240 v service from power plant to household outlet, including transformers.

6) Explain the use of voltammeter's digital and analog.

7) Check an outlet for correct wiring with a voltammeter.

8) Operate a watt-hour meter.

9) Operate and interpret various control devices such as relays, thermostats, pressure switches, etc.

10) Explain ways in which the above controls are interconnected in a typical heating plant.

11) Explain the operation of the various types of electric motors, their advantages and disadvantages.

12) Explain efficiency, coefficient of performance, and energy efficiency ratio calculations for typical devices.

13) Find and use various sources of information about electricity and electrical devices. (Sears catalog)

ELECTRICITY SYLLABUS

Session #	Hours	Objectives	Topic
1	1	1,2,3	Fundamental principles of electrical current, e.g., resistance and conductance - Ohm's law - Components of electrical circuit - Units of resistance - Wire gauge sizing - Relationship of power to work and time - Sample wattage draws of three common household items
2	1.5	4,5	Same as Session 1; AC/DC; A/C generation; delivery of power from source to outlet
3	1.5	5,6,7	Identifying and checking for correct wiring of outlets and other circuits (use voltammeters, etc.) - Grounding of appliances
4	1.5	6,7	Same as Session 3
5	1	8,9,10	Role of electricity in the basic function of a thermostat, a watt hour meter and single pole/double-throw switches; Quiz
6	1.5	11	Role of electricity in the function of basic mechanical devices: 1) small motors, 2) fans/blowers, 3) resistance heat, 4) pumps, etc.
7	1	11	Same as Session 6
8	1.5	12	Finish motors - Principles of electric heat
9	1	12	How to test the energy efficiency rating of various pieces of electrical equipment (e.g., appliances), (Use watt-hour meter, etc.) Coefficient of performance
10	1.5	11,12,13	Energy efficiency ratios; Air conditioning systems; Water heaters and ground-fault interrupters
11	1		Examination

PROJECT EFFECT - IUSB

Electricity

QUIZ #1

1. A circuit consists of a voltage source, V, connected to a resistor. If voltage is doubled,

   a. the resistance doubles
   b. the resistivity doubles
   c. the current doubles
   d. the current is cut in half

2. The units of resistance are:

   a. coulombs
   b. charge
   c. amperes
   d. ohms

PROJECT EFFECT - IUSB

Electricity

QUIZ #2

Circle the best answer

1. A toaster uses 5 amps at 120 v. This means the toaster uses

   a. 120 watts
   b. 5 watts
   c. 24 watts
   d. 600 watts

2. A fuse is placed in a circuit so that

   a. the wires do not overheat
   b. the chance of an electrical fire is reduced
   c. to limit the current in the circuit
   d. all of the above

PROJECT EFFECT - IUSB

Electricity

QUIZ #3

Circle the best answer to the following:

1. The energy used in an electrical appliance is

   a. the rating in volts times the rating in amps
   b. the rating in amps times the time the appliance is on
   c. the rating in watts times the time the appliance is on
   d. the rating in volts times the rating in watts

2. At 5¢ per kilowatt-hour, how much does it cost to leave a 100 watt, 120 volt light bulb on for 10 hours?

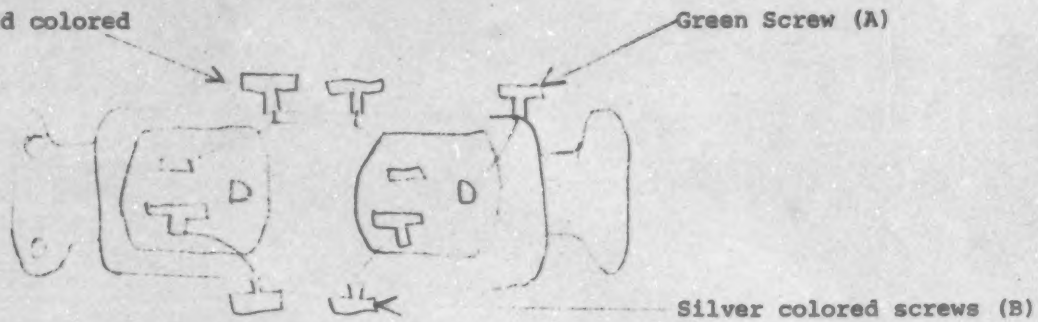
   a. 5¢
   b. 60¢
   c. 1/2¢
   d. 6¢

PROJECT EFFECT - IUSB

Electricity

QUIZ #4

A cable with three #12 wires comes from a fuse box to an outlet. One wire has black insulation, another has white insulation, and the third has no insulation. These wires are to be connected to the terminals of the outlet. Refer to the outlet diagram below:



a. The hot lead (wire) has _____ insulation.

b. The neutral lead has _____ insulation.

c. The ground lead has _____ insulation.

d. The green screw is attached to the _____ lead.

e. The gold screw is attached to the _____ lead.

f. The silver screw is attached to the _____ lead.

PROJECT EFFECT - IUSB

Electricity

QUIZ #5

1.

The watt-hour meter readings are:

_____ _____ _____ _____

2.

_____ _____ _____ _____

ELECTRICITY MODULE
1979 Test

I. Connect by a line the best answers from the second column with the items listed in the first column.

1.	Ampere	A.	Electrical energy unit
2.	Voltage	B.	Resistance unit
3.	Watt	C.	Converts chemical energy into electrical energy
4.	D.C.	D.	Current flowing in one direction
5.	Ohm	E.	Electrical pressure
6.	Battery	F.	Current unit
7.	Conductor	G.	Electrical power unit
8.	Kilowatthour	H.	Alternating current
9.	A.C.	I.	Temperature controlled switch
10.	Thermostat	J.	Low resistance material

II.

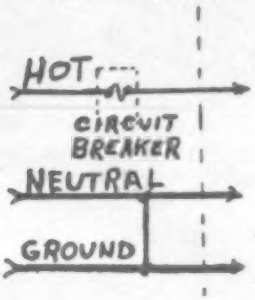
If this was a pointer registed kilowatt-meter, what is this reading?

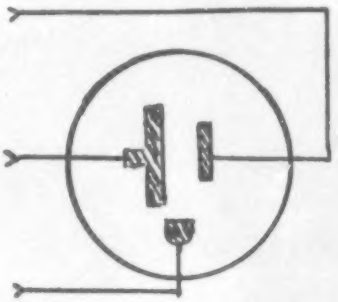
_____ _____ _____ _____._____ kilowatt-hours

III. If the average household uses six-60-watt light bulbs from 7 pm to 12 pm nightly. How many kilowatt hours of electricity are used per month for lighting? (Assume a 30 day month.) At a cost of 5¢ per kilowatthour, how much can be saved by reducing the lighting by turning off half the bulbs?

2-39

IV. A household outlet is connected to a circuit breaker box with non-metalic sheathed cable. It consists of three copper wires, one with white insulation, one with black insulation and the third with green insulation. Draw three lines from the breaker box represented on the left to the outlet represented on the right. Indicate the color of the insulation on each wire.





V. For each of the following, mark T for true, F for false.

_____1. Ohm's law can be written V=iR where V is voltage, i is current, and R is resistance.

_____2. Copper is a good insulator.

_____3. A rotating loop of wire placed in a magnetic field may be used to generate an A.C. voltage.

_____4. The larger the AWG number for a wire, the smaller the diameter of the wire.

_____5. A "ground fault interupter" is a fuse in the ground wire of a circuit.

_____6. An electric current in a wire creates a magnetic field around the wire.

_____7. When an electric wire is cut the electricity leaks out?

_____8. The E.E.R. of an appliance is the "Energy Electric Resistance" of that appliance.

_____9. AWG number 14 copper wire has more resistance per foot than AWG number 12 copper wire.

_____10. Transformers work on A.C. but not D.C.

VI. For each of the following, if it is a property of a "universal type motor" circle "A", if a "split phase induction motor", circle "B", and if a "capacitor start motor" circle "C". One property may have more than one correct letter.

1.	Runs on A.C.	A	B	C
2.	Runs on D.C.	A	B	C
3.	Kitchen blender	A	B	C
4.	Furnace fan	A	B	C
5.	Has brushes	A	B	C
6.	Refrigerator compressor	A	B	C

VII. Why do modern plugs and outlets have a 3-prong connection instead of the older 2-prong?

VIII. 1. At full load, the motor at the right draws how many amperes if connected to a 115 volt source?

(1 hp=746 watts).

$77.99

Capacitor-start ½-HP Motor

For hard-starting belt-driven blowers.
CONSTRUCTION. Sleeve bearings. 1725 rpm. Single-end ⅝-inch shaft, 3/16-inch square keyway. Resilient mount—3x4⅞ inches (NEMA 56 frame). Mount any position, drip-proof in horizontal.
ELECTRICAL INFORMATION. 115 or 208–230-volt, 60-Hertz AC. 650 full-load input watts. No cord or switch. Overload protector. Electrically reversible.
ORDERING INFORMATION: See warranty below.
9 A 1972C—Shpg. wt. 22 lbs. $77.99

2. What is the efficiency of this motor in converting electric energy into mechanical energy?

INTRODUCTION TO COOLING SYSTEMS 23 HOURS

Space conditioning (or air-conditioning) is a major energy user in many parts of the United States. A thorough technical understanding of the basic operation of standard cooling systems, how to calculate their energy consumation and how to evaluate Energy Conservation Opportunities, is an essential component in the ability to make energy conservation recommendations in this area.

PRE-REQUISITES: Introduction to Energy
Math and Algebra Basics
Graphics (desirable)

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: 8th grade - basic algebra

Dexterity: N.A.

Spatial Orientation: Ability to do schematic drawings of cooling plant

INTRODUCTION TO COOLING SYSTEMS

OBJECTIVES

1) Understand basic refrigeration cycles: a) compression, b) absorption, c) evaporation

2) Know the equipment required for each cycle: a) compressors, b) evaporators/chillers, c) condensers

3) Design a cooling building

4) Determine cooling plant capacity: a) sensible load, b) latent load/dehumidification

5) Calculate annual energy consumption and costs and energy conservation opportunities for cooling systems

RESOURCES

Handouts

1. Handout #1, "Refrigeration and Air Conditioning"
2. Handout #2, "Cooling"
3. Handout #3, "How to Estimate How Much Electric Power You Will Need to Cool Your Home in Summer -- and How Much It Will Cost"
4. Handout #4, "Heat Pumps"
5. Handout #5, "Application Guide -- Weathertron Heat Pump"

BOOKS AND REFERENCES

1) ASHRAE Handbook, Fundamentals, 1972
2) ASHRAE Handbook, Equipment, 1973
3) ASHRAE Handbook, Applications, 1974

COOLING SYLLABUS

Session #	Hours	Objectives	Topic
1	2	3a,b	Introduction to cooling
2	1	3a,b	Design cooling load; Heat gain calculations
3	3	3a,b	Heat gain (specific heat, sensible heat, latent heat); Condensation and evaporation
4	3	1	Pressure/temperature relationships for gases; Boyle's Law; Compression; Refrigeration Cycle
5	3	3b,4	Annual energy, fuel and cost consumption for cooling systems; Calculate: AFC-C, AEC-C; estimated ADC-C energy efficiency ratios; humidity, dry bulb and wet bulb temperature
6	3	4	Evaluating Energy Conservation Opportunities for cooling system (e.g., insulation, storm windows)
7	3	4	Cooling Energy Conservation Opportunities continued
8	2		Part I of Cooling examination
9	2	1,2,3,b	Types of cooling equipment; Psychrometric charts; Humidity control; Sizing of humidifier
10	2		Cooling test - Part II
11	2	2,3,4	Heat pumps

PROJECT EFFECT

Introduction to Cooling - Final Exam PART I

I. Given the following design factors:

1) outdoor dry bulb 90°F
2) indoor dry bulb 75°F
3) outdoor range 20°F
4) indoor temperature swing 3°F
5) a. 8" masonry walls R 3
   b. 2" solid wood doors R 2.33
   c. ceiling under naturally vented attic R 7 - roof color - light
   d. the house is over a "Michigan" (partial) basement, with an open crawl space measuring 19'0" x 28'0" floors have R 4
   e. six people live in the house, located in South Bend, Indiana
   f. ducts are located in conditioned space
   g. no mechanical ventilation

II. Find the following: (40 points)

A. Design Cooling Load - If cooling units are available in ½ ton increments, what size unit would be required to meet this load?

B. Annual Energy Consumption - Cooling

C. Annual Fuel Consumption - Cooling

D. Annual Dollar Consumption - Cooling

III. The same house will soon be adding an R of 30 to its attic at $.35/ft^2 installed cost. (20 points) Find the following.

A. Total annual energy savings (Heating and Cooling)

B. Annual Fuel Savings

C. Annual Dollar Savings

D. Payback period

E. Return on Investment

ALL WORK MUST BE SHOWN IN CLEAR DETAIL AND LABELED PROPERLY.

JDR:ja/5/17/79

PROJECT EFFECT

Cooling Systems Final - Part II

Fill in the blanks: (28 points)

1, 2) Heat energy involved in changing a substance from a liquid to a gas (or vice-versa) is called _____, while that involved in changing a substance from liquid to solid (or vice-versa) is referred to as _____.

3, 4) According to the combined Boyle's and Charles' Law, if the temperature of a gas increases (while the pressure remains constant), its volume will _____, and if the pressure increases (while the temperature remains constant), volume will _____.

5) The removal of heat at a rate of 200 Btu/min., 12,000 But/hr or 288,000 Btu/day is defined as one _____ of refrigeration.

6, 7, 8, 9) If a given volume of air contains as much water vapor as it can hold under existing temperature and pressure conditions, it is said to be _____; the relative humidity is _____percent; and the dry bulb temperature is the same as the _____ temperature and the _____ temperature.

10, 11) Relative humidity of any parcel of air depends upon a) _____ _____ and b) _____.

12, 13) In the mechanical compression refrigeration cycle, latent heat is _____ by the refrigerant in the evaporator coil, and latent heat is _____ by the refrigerant in the condenser coil.

14, 15, 16, 17) In the low pressure portion of the compression refrigeration cycle, the refrigerant temperature is _____ than its boiling point (and the refrigerant must turn into a superheated _____ state. On the high pressure side, the refrigerant temperature is _____ than its boiling point (and the refrigerant must change into a _____ state).

18) _____ equipment is classified by the way it is cooled: by forced air (smaller projects), by evaporation plus forced air, or by pumped water with a cooling tower (larger projects).

19,20) _____ compressors use a piston action like an automobile engine and are used on smaller refrigeration systems. _____ compressors use force developed by rotation of an impeller and would always be used with a chiller on air conditioning projects.

21,22) In a(n) _____ cooling coil, air surrounding the coil is cooled when liquid refrigerant expands and boils within the tubes of the coil. In a(n) _____ cooling coil, cold water (secondary refrigerant) supplied from a refrigeration machine flows inside the tubes and cools the air flowing around the coil.

23, 24, 25) In addition to cooling the conditioned air, a mechanical refrigeration machine also removes _____ from the air through _____ on the cooling coil. To best accomplish this, the air conditioner should be sized to run as _____ of the time as possible without undersizing.

26) A(n) _____ refrigeration machine is similar to a compression machine, but uses heat from a fuel burner or steam line to do work on the refrigerant.

27, 28) In the _____ season, when specific humidity is low, a humidifier is needed to raise the indoor relative humidity to _____ percent, the minimum level for comfort. In the _____ season, when the specific humidity is high, dehumidification is necessary to lower the indoor relative humidity to _____ percent, the maximum level for comfort.

Solve the following problems. Show all work as only partial credit will be given for answers only. Use back of test pages if necessary. (12 points)

Given: Outdoor air at 40^0F dry-bulb,
relative humidity 60 percent

Using your psychrometric chart or table, find:

29) Wet-bulb temperature

30) Dew-point temperature

31) Relative humidity when heated to 70°F

32) How much specific humidity must increase to achieve conditions within the so-called "comfort zone".

A 6000 Btu/hr compression refrigeration machine uses 800 watts to add 12 Btu/lb of heat to the refrigerant while the evaporator coil achieves a cooling effect of 44 Btu/lb of refrigerant.

33,34) What is the coefficient of performance (COP) of the machine?

35,36) What is the energy efficiency ration (E.E.R.) of the machine?

Given: 5 lbs. of ice at 32°F
FIND:

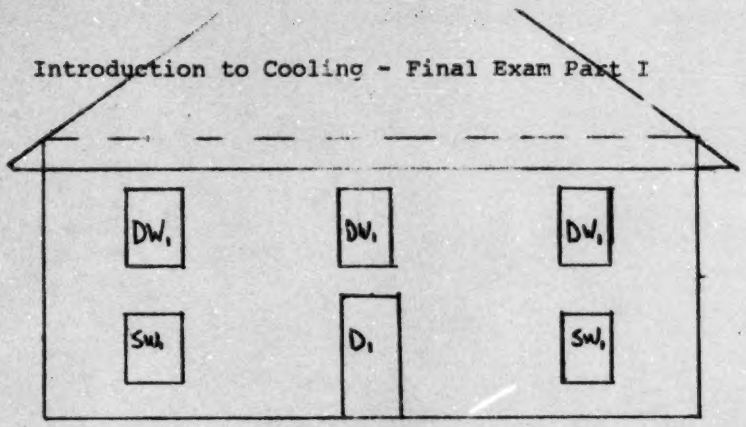
37,38) Total heat needed to change the ice to steam at 212°F

39) How much of this heat is latent?

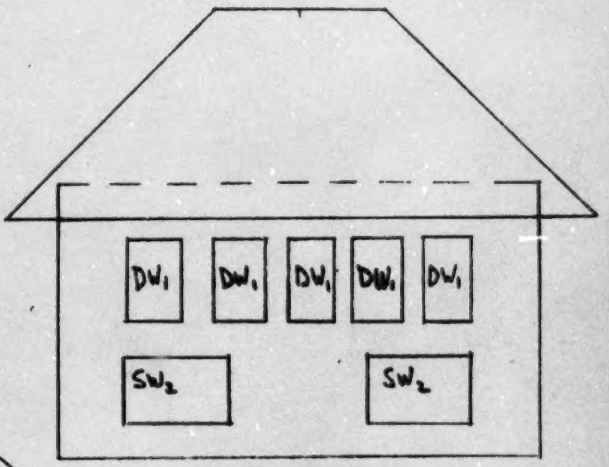
40) How much of this heat is sensible?

Elevation Views

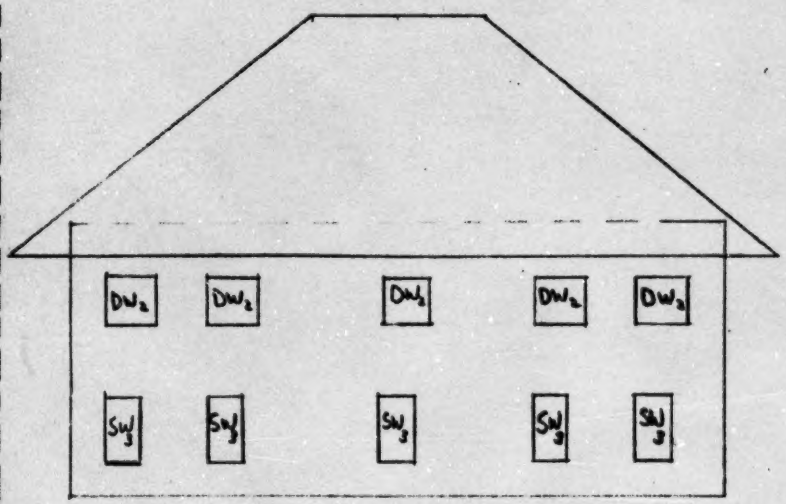
2-47



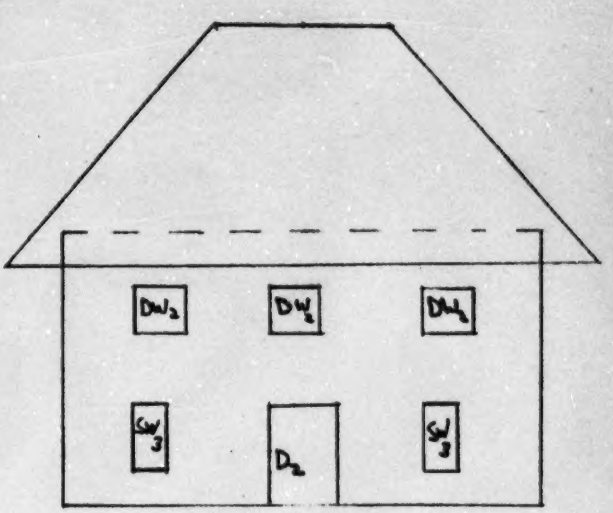
South East



North east



North west



South west

	width	height	
DW_1	3'0"	5'0"	} roller shades
DW_2	3'0"	3'0"	
SW_1	3'0"	4'0"	no inside shading
SW_2	6'0"	4'0"	awnings
SW_3	2'0"	4'0"	venetian blinds
D_1	3'0"	7'0"	
D_2	4'0"	6'0"	

DW = wind w/storm (double glass)
SW = single glass
O.H = Overhang

Top of 2nd story wall to Bottom of O.H.	2'0"
Bottom of O.H. to top of windows	1'0"
Width of O.H.	2'6"
Height of Wall	16'0"
Long dimension of bldg (SE, NW)	38'0"
Short dimension of bldg (NE, SW)	28'0"

Form No. 300 Plan Rev. Apr. 1980.

INTRODUCTION TO HEATING SYSTEMS 37 HOURS

In most portions of the U.S., space heating is by far the major energy user. A thorough technical understanding of heating systems (i.e., their basic operation and how to monitor their efficiency) is essential to making comprehensive energy conservation recommendations for the "environmental control" of a light structure.

A practical "hands on" approach includes the opportunity to observe a number of different types of heating systems. The teaching is done primarily by project staff in consultation with a professional heating contractor.

PRE-REQUISITES: Basic Math, Energy Overview, Basic Graphics and Blueprint Reading
Related: Cost Calculations, Energy Use Survey

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: 8th grade

Dexterity: N.A.

Spatial Orientation: Ability to draw schematic diagram of a heating system

INTRODUCTION TO HEATING SYSTEMS

OBJECTIVES

1) Define the basic components of comfort and heat transfer (balance between body heat loss and heat production; conduction, radiation, convection-forced and natural; heating degree days; district heating factor; Design Temperature Difference).

2) Apply Btu values of common fuels (Natural gas, LP, Propane, #2 fuel oil, Coal, Wood, Electricity) to heating requirements.

3) Describe the components that make up the building envelope; explain composition of individual components; calculate the rate of heat transfer through different components, infiltration/ventilation heat loss, and complete building heat loss and annual heating requirements.

4) Explain the effects and calculate savings resulting from various energy conservation measures in relation to building heating requirements.

5) Define the components, operations, and efficiencies of various types of heating equipment; principles of combustion.

6) Describe the various combinations and arrangements of equipment used in all types of heating, ventilating and air conditioning systems.

RESOURCES

HANDOUTS

1) Handout #1, "The Components of Comfort: Do You Remember Them?" from Basic Electric Heating
2) Handout #2, "Resistance Values of Structural and Finish Materials"
3) Handout #3, "Basic Information, Definitions and Terms"
4) Handout #4, "Insulating Values of Materials"

BOOKS AND REFERENCES

1) ASHRAE Handbook, Equipment, 1972, American Society of Heating, Refrigerating and Air Conditioning Engineers, Publishers, New York, NY
2) ASHRAE Handbook, Fundamentals, 1973, American Society of Heating, Refrigerating and Air Conditioning Engineers, Publishers, New York, NY
3) ASHRAE Handbook, Applications, 1974, American Society of Heating, Refrigerating and Air Conditioning Engineers, Publishers, New York, NY
4) Project RetroTech, Home Weatherization Manual, Federal Energy Administration, Office of Weatherization for Low-Income, Washington, D.C., 1975, 1976
5) Building Mechanical Systems, F.T. Andrews, Chapter 3, pp. 27-55

HEATING SYLLABUS

Session #	Hours	Objectives	Topic
1	2	1,2	Basic heat loss concepts; components of comfort; heat transer; body heat loss; relative humidity; heating degree days; Btu values of common fuels
2	2	1,3	Review session 1; heat loss formula review; heat transfer - units of measurement; Define K, C and U values, and district heating factor for annual heat loss
3	3	3	Conduction heat loss through walls, ceilings and floors; Exposure factors through ceilings, floors, unheated areas; Figure total heat loss on insulated and uninsulated house
4	2	5	Principles of heat production and delivery of heat transfer; Types of systems (advantages and disadvantages)
5	3	5	Review of automatic fuel-burning equipment; Review heat loss calculations
6	2	5	Same as Session 5
7	6	3,5	Field Day: Measure actual houses; Do flue-gas analysis on furnaces

2-52

PROJECT EFFECT

Heating Systems Exam

PART I (60 points)

A local house has recently been audited for energy efficiency. The following conditions are given:

two-story house in South Bend, IN
unheated moderately tight basement
basement wall above grade is less than 3 feet. Wall height first floor = 8 feet
Wall height second floor = 7.5 feet
well-ventilated attic
gas furnace, efficiency of 70%

$.25/ccf for natural gas
comfort level 70°F.
Draft factors:
Basement 1
Windows 1
Doors .5
Walls .5
Mineral Wool R = 3.3/inch
R-value of doors = 2

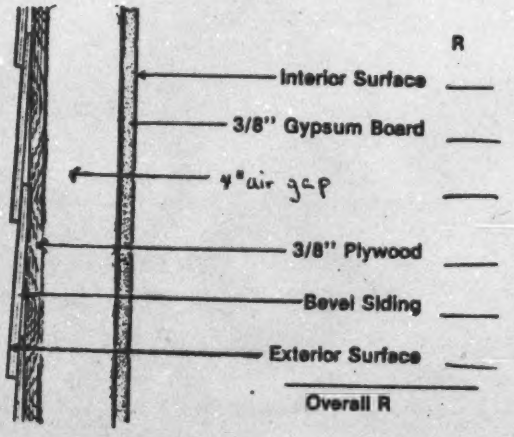


Figure 1 U-value

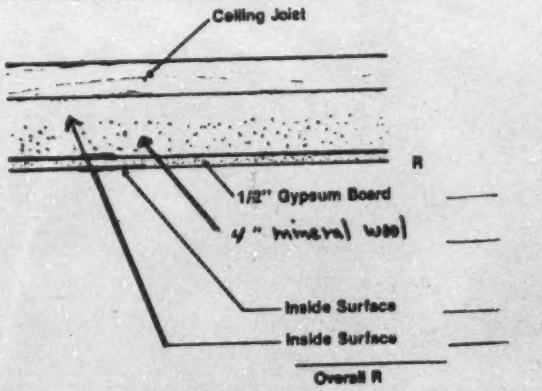


Figure 2 U-value

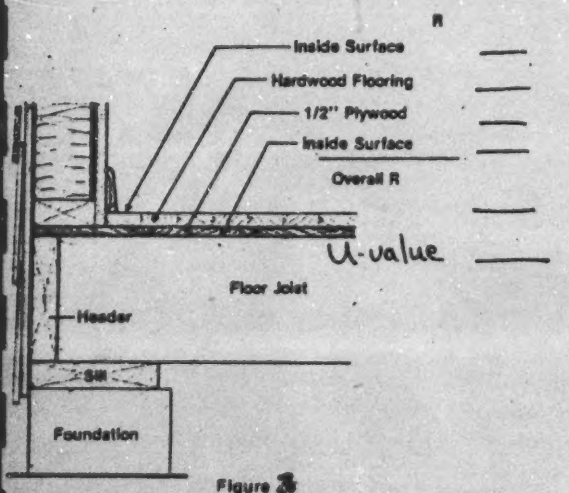


Figure 3

WALLS all windows are single pane glass

orientation	North	South	West	East
Length	23 ft	23 ft	25 ft	25 ft
Height	15 ft	15 ft	15 ft	15 ft
# of windows	5	5	5	6
Area of wind	57 ft²	40 ft²	40 ft²	56 ft²
Area of doors	20 ft²	20 ft²	18 ft²	none

figure 4

Project EFFECT - Heating System Exam

2-53

Please show all work, and label answers with appropriate units. Only partial credit can be given for answers only.
(all work shoud be done on the front and/or back of the test pages)

1. (9 points) List the component R's, total R's, and U-values for the three figures on page 1.

2. (1 point) What is the gross wall area of the northern exposure?

3. (5 points) Find the Annual Energy Consumption (AEC) for infiltration.

4. (16 points) Find the Annual Energy Consumption (AEC), Annual Fuel Consumption (AFC), Design Heating Load (DHL), and Annual Dollar Consumption (ADC), due to conduction for the walls, windows, and doors for the southern exposure.

5. (4 points) Find the Design Heat Load (DHL) for the ceiling

6. (1 point) Find the net wall area for the eastern exposure

7. (24 points) Find the AES, AFS, ADS, Payback Period (PP) and Return on Investment (ROI) for the installation of storm windows at $30 per storm window.

Heating Systems Exam

PART II (40 points)

1) The difference between the indoor comfort level temperature (usually 70°F) and the outdoor design temperature (ASHRAE 99% value for South Bend = 2°F) is called the _____.

2) _____ are a measure of weather severity obtained by subtracting half the difference between the daily maximum and minimum temperatures from 65°F.

3) If No. 2 fuel oil costs $2.50 per million Btu's (MMBtu), how much is a barrel of oil (42 gal.) worth? (Show your work).

4) The annual energy consumption (AEC) or heating output of a heating system divided by the annual fuel consumption (AFC) or fuel input to the system is called _____ of the system.

5) _____ combustion occurs when a fuel is burned in the presence of excess air, while _____ combustion results from insufficient air.

6) The boundaries between conditioned and unconditioned spaces in a structure are referred to as the _____.

7) A portion of an HVAC system which is subject to fairly uniform conditioning loading and is controlled by a single sensor (thermostate, etc.) is called a(n) _____.

8) An HVAC system which controls room temperature by varying the temperature of an unvarying amount of room supply air is called a(n) _____ system, while one that uses differing amounts of a constant temperature air supply controlled at the room terminal is called a(n) _____ system.

9)

Label the four components of the airflow in this HVAC system.

a. _____ c. _____

b. _____ d. _____

10) A(n) _____ system uses a relatively small amount of high velocity primary airflow to satisfy room ventilation needs and pull secondary (room) air thru a terminal unit equipped with hot and cold water conditioning coils piped from a central plant (usually no return air).

Heating Systems Exam

11) In the _____pipe system, hot and chilled water are supplied to separate coils and returned individually to their respective heating and cooling sources.

12) _____ controls use air at 10-25 psi to operate thermostats, dampers and valves.

13) In a hot water heating system, heat production takes place in a(n) _____ and a(n) _____ is used to circulate the medium, while a(n) _____ produces heat and a(n) _____ circulates the medium in a hot air heating system.

14) A flue-gas analyzer most commonly measures the percent of _____ in the flue gases to determine combustion efficiency.

15) Match the four arrangements possible in a forced-air furnace with the appropriate name

upflow highboy	supply-side, return-side
upflow lowboy	supply-top, return-bottom
counter flow	supply-top, return-top
horizontal	supply-bottom, return-top

16) The slightly pressurized supply air duct coming out of a furnace is called the _____.

17) Name the four media used in heating systems.

a._____ c._____

b._____ d._____

18) A(n) _____ heating system uses hot water piping coils or electric resistance coils imbedded in the ceiling to heat objects within the room without directly heating the air.

INSULATION AND VENTILATION 18 HOURS

The composition of the outer perimeter (thermal envelope) of a structure is a major component in determining the efficiency of energy utilization. The condition of this "envelope" determines whether the energy meant for space conditioning is being utilized efficiently. Students must be able to recognize those energy use problems which arise from a faulty "envelope" and be able to make appropriate recommendations. Infiltration, insulation, and ventilation are major components in the analysis of the thermal envelope.

A professional insulation contractor works closely with Project staff to develop this module and ensure continuity of instruction. Samples of insulation and other weatherization materials are available for students' inspection, and students have the opportunity to observe proper installation procedures in the field.

PRE-REQUISITES: Introduction to Heating, Introduction to Cooling, Energy Overview and Blueprint Reading

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: 8th grade

Dexterity: N.A.

Spatial Orientation: Ability to read blueprints

INSULATION AND VENTILATION

OBJECTIVES

1) Explain heat transfer terms and types of heat flow.

2) Identify types of insulation and weatherization materials.

3) Explain properties and uses of different types of insulation in residential construction.

4) Understand the need for ventilation.

RESOURCES

HANDOUTS

1) Handout #1, "Insulation", U.S. Department of Energy Distribution, Washington, D.C., February 1978
2) Handout #2, Materials provided by the American SPE Corporation
3) Handout #3, "History of Fiberglas", Richard Baker, Johns-Manville Fiber Glass Customer Service Training Manual, August 1974
4) Handout #4, "Basic Information, Definitions and Terms", Aerolite SPE Corporation, 1978
5) Handout #5, "Orientation and Training Course on 'Aerolite" R U F Thermal Insulation Foam", ASHRAE Handbook of Fundamentals, published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers
6) Handout #6, "A Guide to Proper Installation" by The Incel Corporation
7) Handout #7, "Thermal Insulation and Vapor Barriers"
8) "Condensation Problems in Your House: Prevention and Solution", by L.O. Anderson and G.E. Sherwood, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, Madison, Wisconsin

BOOKS AND REFERENCES

1) ASHRAE Handbook of Fundamentals, 1972, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, publishers, New York, NY, chapter 20.
2) TVA Energy Conservation Materials, Tennessee Valley Authority, Division of Power Utilization 1974-1977
3) The Solar Home Book - Heating, Cooling and Designing with the Sun, Bruce Anderson and Michael Riordan, Cheshire Books, Harrisville, NH, 1976
4) Insulation Manual - Homes, Apartments, National Association of Home Builders, Inc., Rockville, MD, September 1971

INSULATION SYLLABUS

Session #	Hours	Objectives	Topic
1	3	1,2	Introduction to insulation. Types of insulation, properties, quality control, manufacturing processes, R-values relative to temperature, ASHRAE U-values
2	3	3	Appropriate uses of insulation, installation techniques and representative prices
3	3	4	Condensation, vapor barriers and ventilation principles
4	6	1	Field trip - visit recently foamed house. Observe ventilation, weatherstripping, vapor barriers and condensation
5	3		Review and examination

2-60

PROJECT EFFECT - 1979
INSULATION MODULE FINAL EXAM

A. (60 pts.) Name four (4) types of insultation material and give or briefly discuss:

2 pts. each	1.	Common form(s)
	2.	R, K, C and U-values of:
1 pt. each		a) 3½ in. thickness
		b) 6 in. thickness
2 pts. each	3.	Two advantages
2 pts. each	4.	Two disadvantages
	5.	The best application (use) of the material including:
1 pt. each		a) Where to apply it (walls, attics, etc.)
1 pt. each		b) Form and method of installation
2 pts. each		c) Approximate cost of 1000 sq. ft. installed
2 pts. each	6.	How to make the material "firesafe"
1 pt. each	7.	One manufacturer of the material

B. (10 pts.) Fill in the blanks:

1. The length of time it takes foam to change from a "shaving cream" consistency to the point where it is firm enough to slice with a knife is called _____.

2. The U-value of a building/insulating material _____ as the temperature increases.

3. _____ are the result of insufficient insulation and/or ventilation in an attic.

4. _____ occurs when water vapor is cooled to a temperature below its dew point.

5. A vapor barrier should always be placed on the _____ side of insulation in a wall, ceiling or floor.

C. (30 pts.) Referring to the attached drawing of a house (Fig. 1):

10 pts.	1.	Indicate by shading where insulation should ideally be installed in the structure.
	2.	Identify each structual area by name and tell:
10 pts.		a) What form and type of insulation should be installed
10 pts.		(b) How much should be installed to meet the suggested R-values for the South Bend area (neglect R-value of existing building materials).

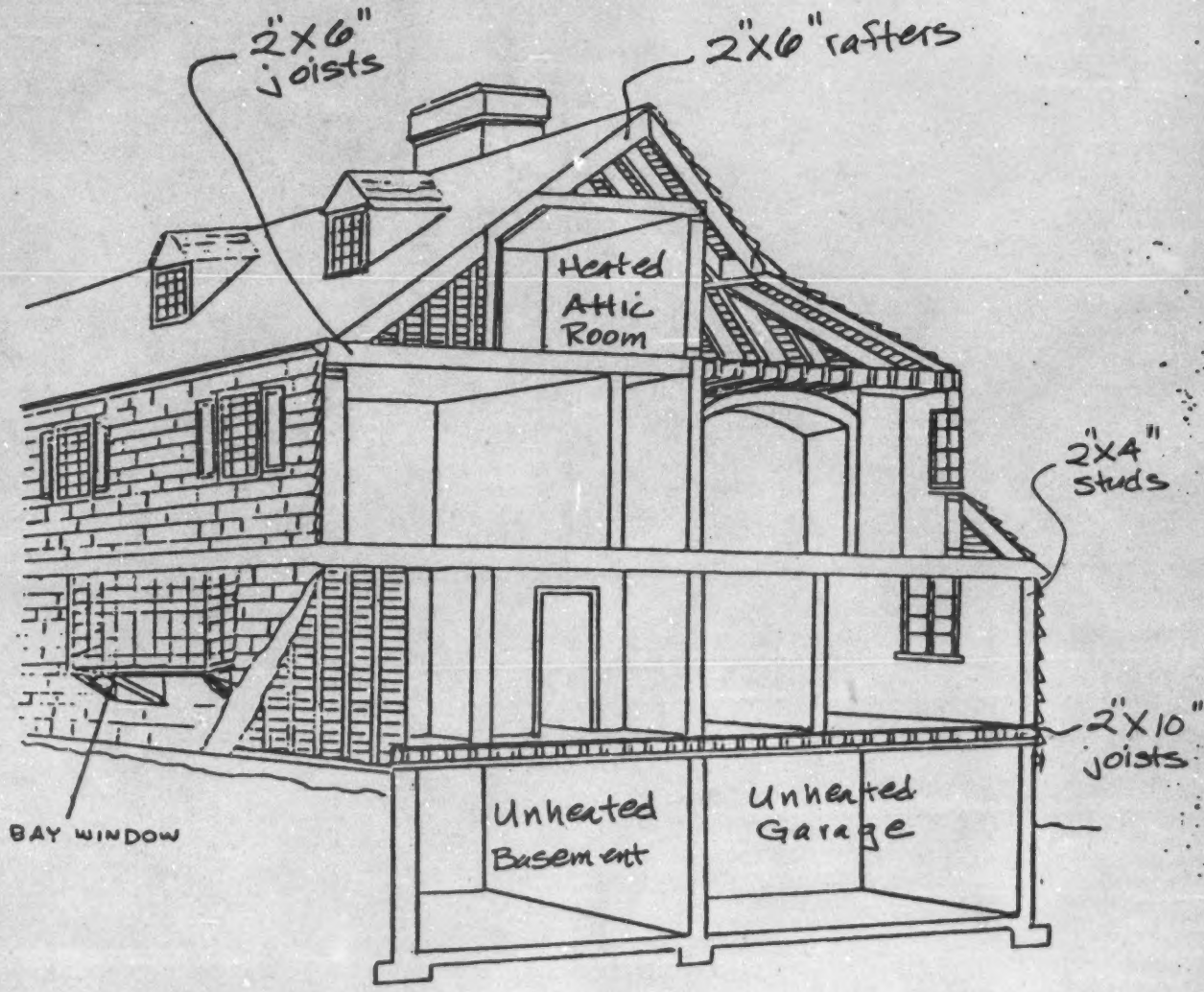

2"x6" joists
2"x6" rafters
Heated Attic Room
2"x4" studs
2"x10" joists
BAY WINDOW
Unheated Basement
Unheated Garage

Figure 1

LIGHTING EFFICIENCY 20 HOURS

This highly technical unit teaches students to measure light intensity and calculate light source requirements for variable tasks. Students learn to make recommendations which are not difficult or expensive to implement and which have a relatively large return in terms of energy saved. Students are required to learn a new technical vocabulary and to complete some challenging mathematical calculations.

PRE-REQUISITES: Mathematics Review, Electricity

COGNITIVE SKILLS:

Reading and writing level: 8th grade

Math level: Algebra, graph reading

Dexterity: N.A.

Spatial orientation: Ability to schematize lighting installations on diagram
Ability to read blueprints

LIGHTING

OBJECTIVES

1) Define the different terms for source strength, candle power, candela, lumen, etc., and ability to convert one to the other.

2) Compare the advantages and disadvantages of various incandescent sources such as tungsten, argon filled and quart-iodine bulbs and their spectral responses.

3) Define the terms for illumination, foot candles, lux, dekalux, and how to calculate the illumination of a surface for one or more point sources.

4) Calculate the efficiencies of various sources.

5) Explain the operation of arc sources and fluorescent bulbs and fixtures.

6) Find the illumination levels recommended by the Illuminating Engineering Society and interpret the tables.

7) Use a simple foot-candle meter.

8) Perform a lighting level survey and recommend any changes that will result in an energy and cost saving along with estimating the "energy savings payback" period.

RESOURCES

HANDOUTS

1) Handout #1, "Light and Illumination"
2) Handout #2, "Lighting"

BOOKS AND REFERENCES

1) Understanding and Using Electricity, McKenzie and Zacharich, Interstate, Unit II
2) Lighting and Thermal Operation: Energy Management Action Program for Commercial, Public, and Industrial Buildings, Federal Energy Administration
3) I.E.S. Lighting Handbook, Illuminating Engineering Society, New York, NY (1972), Sections 4-26 to 4-30
4) An Interim Report Relating the Lighting Design Procedure to Effective Energy Utilization-EMS-2. Illuminating Engineering Society, New York, NY (1978)
5) The Sears Roebuck and Company Big Book, Spring 1979, pp. 1010-1025
6) Energy Conservation Program Guide for Industry and Commerce, NBS Handbook 115, Supplement 1, Section 3017A to D

LIGHTING SYLLABUS

Session #	Hours	Objectives	Topic
1	1.5	1	Basic lighting terminology
2	1	2	Advantages and disadvantages of various types of lighting. Illumination Intensity
3	1.5	3,4	Session #2 continued Illumination Calculations
4	1	4	Same as above
5	1.5	5,6	To determine surface illumination and light source requirements; Fluorescent lighting, x-rays
6	1	5,6	Session #5 continued
7	1.5	1-6	Conduct a lighting survey of a structure (complete with improvement (qualitative) recommendations)
8	1	7	Session #7 continued, using a foot-candle meter
9	6	8	Lighting Survey - all day
10	1.5	8	Review of Lighting Survey
11	1	1-8	Review for final exam
12	1.5		Exam

Project EFFECT
Lighting Module Test

2-65

1. (2 points) $2x + 1 = 5$; $x = ?$

2. (2 points) $2x + 8 = x - 8$; $x = ?$

3. (4 points) $x + y = 9$ $x = ?$
   $x - y = 1$; $y = ?$

4. (3 points) A one candle power light source (a candle?) emits how many lumens in all directions?

5. (3 points) A one candle power light source emits how many lumens into a solid angle of 1 steradian?

6. (4 points) If a Sylvania 60 watt Soft White bulb emits 800 lumens, what is the approximate candle power of this light?

7. (4 points) What is the luminous effeciency of the bulb in question six in lumen per watt?

8. (4 points) One lumen is 1.46 milliwatt of light energy. For the bulb in question 6, how many watts of light energy do you get per electrical watt of power into the bulb?

9. (3 points) What is the illumination on a surface that is one foot from a point light source of intensity one candle power?

10. (4 points) What is the illumination on a surface that is two feet from a point light source of 2 candle power?

11. (5 points) What is the illumination on a surface that is two feet from a point source that emitts 250 lumens?

12. (4 points) What is the recommended illumination level for typing in an office in foot candles? In dekalux?

13. (2 points) A dekalux is how many lux?

14. (5 points) A 50 watt G.E. bulb emits about 600 lumens. If this bulb was placed 4 feet above a level surface, what is the illumination on that surface directly below the bulb?

15. (5 points) How many lumens should the bulb emit if the illumination in question 14 is to be 100 foot candles?

16. (4 points) Besides the illumination level, what other things should be considered in design lighting. (Name two)

17. (4 points) Name some advantages of incadescant lighting.

18. (4 points) Name some disadvantages of incadescant lighting.

2-66

19. (4 points) Why wouldn't you recommend sodium vapor lamps for a window display of a department store?

20. (4 points) Which is more efficient, a 100 watt incadescent bulb or a 100 watt fluroescent bulb.

21. (4 points) True or False, turning a fluorescent light on takes as much power as leaving the bulb on for 5 minutes.

22. (10 points) If a candle (one candle power) is placed in a candle stick so that the flame is 1 foot above the dining room table, what is the illumination at a plate, on the table, three feet from the base of the candle stick?

23. (4 points) If you find the illumination on a surface that is 2 feet from a single light bulb in 100 lux, what will be the illumination when the surface is moved away to 4 feet from the bulb?

24. (4 points) If you measure the illumination on a surface that is 2 feet from the center of a row of fluorescent bulbs in 200 lux, what will be the measured illumination at a distance of four feet?

25. (4 points) Why is a "ballast" needed in a fluorescent light fixture?

PROJECT EFFECT

TECHNICAL TERM ACRONYMS

HEATING CALCULATIONS

AEC-H = Annual Energy Consumption-Heating
AFC-H = Annual Fuel Consumption-Heating
CHF = Climatic Factor for Heating
FF = Fuel Factor
DHL = Design Heating Load
DHF = District Heating Factor
DTD = Design Temperature Difference
Eff = Efficiency
Th = Therms
Btu = British Thermal Units
ccf = 100 cubic feet natural gas
gal = Gallon(s)
Kwh = Kilowatt hours of electricity

COOLING CALCULATIONS

AEC-C = Annual Energy Consumption-Cooling
AFC-C = Annual Fuel Consumption-Cooling
CFC = Climatic Factor for Cooling
DCL = Design Cooling Load
EER = Energy Efficiency Ratio
EPR = Equipment Power Rating
COH = Cooling Equipment Operating Time

HOT WATER CALCULATIONS

AEC-HW = Annual Energy Consumption-Hot Water
AFC-HW = Annual Fuel Consumption-Hot Water
AHW = Annual Hot Water Consumption
WHW = Weekly Hot Water Consumption
ΔT = Hot Water Thermostatsetting Minus Cold Water Input Temperatu

COST CALCULATIONS

ECO = Energy Conservation Opportunities
AES = Annual Energy Savings
AFS = Annual Fuel Savings
FP = Fuel Price
ADC = Annual Dollar Cost
ADS = Annual Dollar Savings
FC = First Cost
PP = Payback Period
SPP = Simple Payback Period
DPP = Discounted Payback Period
SIR = Savings to Investment Ratio
ROI = Return on Investment
OC = Operating Cost
LCC = Life Cycle Costing
UPVF - Uniform Present Value Factor
AEI = Annual Energy Index
SHI = Space Heating Index